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GA POWER CAPSULE for
SSC & Railway Exam 2019

{General Science: Physics | Chemistry | Biology}

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Contents of SSC & Railway Capsule 2019

General Science Capsule for SSC & Railway 2019

PHYSICS

Physics- It is scientific study of matter and energy and the effect that they have on each other.

MECHANICS

Physical Quantity – Quantities expressed in terms of laws of physics are called Physical Quantities.
There are two types of Physical quantities. They are:

(i) Scalars – The physical quatities which has only magnitude and does not depend on direction is called Scalar quatities. For e.g. length, volume, speed, mass, density, temperature etc.
(ii) Vectors – Vector quantities has both magnitude and direction. For e.g. Displacement, velocity, Accelaration, Momentum etc.

NOTE: A physical quantity which has both magnitude and direction but doesn't obey vector law of addition or subtraction is not a vector quantity. For e.g. Electric current, pressure, work etc.

Unit of measurement – A quantity which is used as a standard of measurement is called Unit of measurement.
There are usually two types of units –

(i) **Fundamental unit** – All those units which are independent of any other unit are called Fundamental units.
There are seven fundamental units. They are:

Fundamental Unit	S I Unit	Symbol
Length	Metre	m
Mass	Kilogram	kg
Time	Second	s
Temperature	Kelvin	k
Amount of substance	Mole	mol
Electric Current	Ampere	A
Luminuous Intensity	Candela	Cd

Supplementary Units		
Plane Angles	Radian	Rad
Solid Angles	Steradian	Sr

(ii) **Derived Units –** All those units which are expressed in terms of two or more fundamental units is called Derived Units. For e.g. velocity (m/s), Accelaration, Force etc.

Dimensions of Physical Quantities – The dimensions of a physical quatity are expressed in terms of powers of Fundamental quantities. For e.g.Velocity=L/T=$[LT^{-1}]=[M^0LT^{-1}]$.

KINEMATICS

Kinematics
Kinematics is branch of mechanics which deals with the study of motion of the objects without taking into account the cause of their motion.

Rest and Motion
An object is said to be at rest if it does not change its position which respect to its surroundings with time and

said to be in **motion** if it changes its position with respect to its surrounding with time.

- **Rectilinear motion** moving car on horizontal road, motion under gravity etc.
- **Angular motion** such as particle going on a circle, projectile motion, rotation of machine shaft etc.
- **Rotational motion** such as motion of a fan.
- It an object travels equal distances in equal intervals of time, then it is said to be in **uniform motion.**
- It an object travels unequal distances in equal intervals of time, then it is said to be in **non-uniform motion.**

Speed

- The distance covered by a moving body in a unit time interval is called its speed.
- Speed $= \frac{\text{Distance travelled}}{\text{Time taken}}$
- When a body travels equal distances with speed v_1 andv_2, then average speed is the **harmonic mean** of the two speeds.
- $\frac{2}{v} = \frac{1}{v_1} + \frac{1}{v_2} \Rightarrow v = \frac{2v_1v_2}{v_1+v_2}$
- When a body travels for equal times with speeds v_1 and v_2, then average speed is the **arithmetic mean** of the two speeds.
- $v = \frac{v_1+v_2}{2}$

Velocity

- The time rate of change of displacement of a body is called its velocity.
- Velocity $= \frac{\text{Displacement}}{\text{Time}}$
- An object is said to be moving with **uniform velocity** if it undergoes equal displacements in equal intervals of time.
- An object is said to be moving with **non-uniform** or **variable velocity** if it undergoes unequal displacement in equal intervals of time.
- Average velocity $= \frac{\text{Time displacement}}{\text{Total time taken}}$

Acceleration

- The time rate of change of velocity of a body is called its acceleration.
- Acceleration $= \frac{\text{Change in velocity}}{\text{Time taken}}$
- It is a vector quantity and its SI unit is ms^{-2}.
- Acceleration at an instant of time is known as **instantaneous acceleration.**
- When the velocity of a body increases with time, then its acceleration is positive and if velocity decreases with time, then its acceleration is negative called **deceleration or retardation.**
- If acceleration does not change with time, it is said to be **constant acceleration.**

Equations of Uniformly Accelerated Motion (Along straight line)

If a body started its motion with initial velocity u and attains final velocity v in the interval t. The acceleration assumed to be uniform in motion is a and the distance travelled is s, then equations of motion:

- $v = u + at$
- $s = ut + \frac{1}{2}at^2$
- $v^2 = u^2 + 2as$
- If any body is falling freely under gravity, then a is replaced by g in above equations.
- If an object is thrown vertically upward, then in above equations of motion a is replaced by (–g).
- For a body with zero acceleration or constant speed, graph between velocity and time will be a line parallel to time axis.
- Velocity–Time Graph For accelerating or decelerating body the graph will be a straight line inclined to time axis and velocity axis.
- Graph between position (distance)-time for an accelerating or decelerating body is always a parabola.
- Acceleration-time graph for uniformly accelerating body is a line parallel to time axis.
- In case of uniform accelerated, the graph between position and velocity is always parabola.
- In case of uniformly accelerated motion, the graph between velocity and time is always a straight line.
- Slope of displacement-time graph gives velocity and slope of velocity-time graph gives acceleration.

Projectile Motion

- When a body is thrown from horizontal making an angle (θ) except 90°, then its motion under gravity is a curved parabolic path, called trajectory and its motion is called projectile motion.

Examples:

- The motion of a bullet shot from the gun
- The motion of a rocket after burn-out
- The motion of a bomb dropped from a aeroplane etc.

Properties of Projectile Motion

If we drop a ball from a height and at the same time thrown another ball in a horizontal direction, then both the balls would strike the earth simultaneously at different places.

Circular Motion

- The motion of an object along a circular path is called circular motion.
- Circular motion with a constant speed is called **uniform circular motion.**
- The direction of motion at any point in circular motion is given by the tangent to the circle at that point.

- In uniform circular motion, the velocity and acceleration both changes.
- In case of non-uniform circular motion, the speed changes from point to point on the circular track.
- **Angular Displacement –** Angular displacement of a body is the angle in radians through which body revolves. It is represented by θ.its S.I. unit is radian.
- **Angular Velocity –** If a body describes an angular displacement in a particular time period, than rate of velocity s known as Angular velocity. It is represented by ω. $\omega = \theta/t$.
- **Projectile Motion –** If a body is projected upward with a certain velocity, then the body describes a path called trajectory path which is parabolic and the motion is known as Projectile motion. A projectile motion is influenced by downward force of gravity.

Centripetal Acceleration

During circular motion an acceleration acts on the body towards the centre, called centripetal acceleration.
The direction of centripetal acceleration is always towards the centre of the circular path.

Force

It is an external push or pull with can change or tries to change the state of rest or of uniform motion. SI unit is newton (N) and CGS unit is dyne. 1 N = 10^5 dyne.
If sum of all the forces acting on a body is zero, then body is said to be in equilibrium.

Centripetal Force

During circular motion a force always acts on the body towards the centre of the circular path, called centripetal force.
$F=mv^2/r=m\omega^2r$.

Centrifugal Force

In circular motion we experience that a force is acting on us in opposite to the direction of centripetal force called **centrifugal force.** This is an apparent force or imaginary force and also called a pseudo force.

Applications of centripetal and centrifugal forces

- Cyclist inclined itself from vertical to obtain required centripetal force. To take a safe turn cyclist slower down his speed and moves on a path of larger radius.
- Roads are banked at turns to provide required centripetal force for taking a turn.
- For taking turn on a curved road, the **frictional force** is acting between the tyres of the vehicle and the road acts as centripetal force.
- If a bucket containing water is revolved fast in a vertical plane, the water may not fall even when bucket is completely inverted because a centrifugal force equal or greater than the weight of water pushes the water to the bottom of the bucket.
- For orbital motion of electrons around the nucleus **electrostatic force** of attraction is acting between the electrons and the nucleus as centripetal force.
- Cream is separated from milk when it is rotated in a vessel about the same axis. During rotation lighter particles of cream experience a lesser force than the heavier particles of milk.
- For revolution of the earth around the sun, gravitational force of attraction between the earth and the sun acts as centripetal force.

Newton's Laws of Motion:

Newton's First Law

A body continues in its state of rest or of uniform motion in a straight line unless an external force acts on it. It is based on **law of inertia**.
Inertia is the property of a body by virtue of which is opposes any change in its state of rest or of uniform motion in a straight line.

Inertia of Rest

- When a bus or train at rest starts, to move suddenly, the passangers sitting in it jerk in backward direction due to their inertia of rest.
- The dust particles come out from a carpet when it is beaten with a stick due to their inertia of rest.
- A passenger jumping out from a rapidly moving bus or train is advised to jump in forward direction and run forward for a short mile due to inertia of rest.

Inertia of Motion

When a running bus or train stops suddenly, the passengers sitting in it jerk in forward direction due to inertia of motion

Momentum

The momentum of a moving body is equal to the product of its mass and its velocity.

Conservation of Linear Momentum

The linear momentum of a system of particles remains conserved if the external force acting on the system is zero.

- Rocket propulsion and engine of jet aeroplane works on principle of conservation of linear momentum. In rocket, ejecting gas exerts a forward force which helps in accelerating the rocket upward.

Newton's Second Law

The rate of change of momentum of a body is directly proportional to the force applied on it and change in momentum takes place in the direction of applied force.

$$F = \frac{\Delta p}{\Delta t} = \frac{m\Delta v}{\Delta t} = ma$$

Newton's Third Law

For every action, there is an equal and opposite reaction and both act on two interacting objects.

Rocket is propelled by the principle of Newton's third law of motion.

Impulse

- A large force which acts on a body for a very short interval of time and produces a large change in its momentum is called an impulsive force.
- Its unit is newton-second.
- A fielder lowers its hand when catching a cricket ball because by lowering his hands, he increases the time of contact for stopping the ball and therefore fielder has to apply lesser force to stop the ball. The ball will also exert lesser force on the hands of the fielder and the fielder will not get hurt.
- Wagons of a train are provided with the buffers to increase the time of impact during jerks and therefore, decreases the damage. The vehicles like scooter, car, bus, truck etc. are provided with shockers.

Friction

Friction is a force which opposes the relative motion of the two bodies when one body actually moves or tries to move over the surface of another body.

The cause of friction is the strong atomic or molecular forces of attraction acting on the two surfaces at the point of actual contact.

Uses of Friction

- A **ball bearing** is a type of rolling-element that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and to support loads (weight).
- Friction is necessary for walking, to apply brakes in vehicles, for holding nuts and bolts in a machinery etc.
- Friction can be decreases by polishing the surfaces by using lubricants or by using ball bearings.
- Tyres are made of synthetic rubber because its coefficient or friction with road is larger and therefore, large force of friction acts on it, which stops sliding at turns.
- The tyres are threading which also increases the friction between the tyres and the road.
- When pedal is applied to a bicycle, the force of friction on rear wheel is in forward direction and on front wheel is in the backward direction.

Loses due to Friction

- Too much Loss of Energy in machines and then ultimately the machines are damaged.

Machine–

- **Lever -** It is a simple machine in which a straight or inclined rod is made to turn or rotate at a point freely or independently. There are three points related to lever namely load, effort and fulcrum.
- **Load** - The weight carried by the lever is called load.
- **Effort** - To operate lever, the force applied externally is called effort.
- **Fulcrum** - The fixed point about which the rod of lever moves independently is called fulcrum.

OSCILLATIONS AND WAVES

Periodic Motion

- A motion which repeats itself identically after a fixed interval of time, is called a periodic motion.
  For example
  - Motion of arms of a clock, orbital motion of the earth around the sun, motion of a simple pendulum etc.

Oscillatory Motion

- A periodic motion taking place to and fro or back and forth about a fixed point is called oscillatory motion.
  For example
  - Motion of a simple pendulum.
  - Motion of a loaded spring etc.
- If a particle oscillates with its own natural frequency without help of any external periodic force. The oscillation is then called **damped oscillation.**
- When a body oscillates with the help of an external periodic force with a frequency different from natural frequency of the body, then oscillation is called **forced oscillation.**

Simple Harmonic Motion (SHM)

- An oscillatory motion of constant amplitude and of single frequency under a restoring force whose magnitude is proportional to the displacement and always acts towards mean position, is called **Simple Harmonic Motion.**

Characteristics of SHM

When a particle executing SHM passes through the mean position:

1. No force acts on the particle.
2. Acceleration of the particle is zero.
3. Velocity is maximum.
4. Kinetic energy is maximum.
5. Potential energy is zero.

When a particle executing SHM is at the extreme end, then:

1. Acceleration of the particle is maximum.
2. Restoring force acting on particle is maximum.
3. Velocity of particle is zero.
4. Kinetic energy of particle is zero.
5. Potential energy is maximum.

Simple Pendulum

- A heavy point mass suspended from a rigid support by means of an elastic inextensible string, is called a simple pendulum.
- Time period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{l}{g}}$
- The time period of a simple pendulum of infinite length is 84.6 min. The time period of a second's pendulum is 2 s. Its length on the earth is nearly 100 cm.
- Acceleration due to gravity decreases with altitude (height) and therefore time period of a pendulum clock will increase and clock becomes slow.
- If the bob of a simple pendulum is suspended from a metallic wire, then the length of the pendulum increases with increase in temperature and therefore its time period also increases.
- A girl is swinging over a swing. If she stands up over the swing, then the effective length of the swing decreases and therefore, the time period of oscillations decreases.
- A pendulum clock cannot be used in a space-ship.

Damped Harmonic Motion

- When there is friction or any other force acting within an oscillating system, the amplitudes of the oscillation decreases over time to this damping force. This is called damped harmonic motion.

Resonant Oscillations

- When a body oscillates with its own natural frequency (V_0) with the help of an external periodic force also called forced harmonic motion. And if the frequency (v) provided by the external agent is equal to the natural frequency of the body, the oscillations of the body are called resonant oscillations.

Wave

A wave is a disturbance which propagates energy from one place to the other without the transport of matter.
Waves are broadly of two types:
1. Mechanical Wave
2. Non-mechanical wave

Mechanical Wave: The waves which required material medium (solid, liquid or gas) for their propagation are called mechanical wave or elastic wave. Mechanical waves are of two types.

1. Longitudinal wave: If the particles of the medium vibrate in the direction of propagation of wave, the wave is called longitudinal wave.

2. Transverse Wave: If the particles of the medium vibrate perpendicular to the direction of propagation of wave, the wave is called transverse wave.

Waves on strings under tension, waves on the surface of water are examples of transverse waves.

Non-mechanical waves or electromagnetic waves: The waves which do not require medium for their propagation i.e. which can propagate even through the vacuum are called non mechanical wave.

Light, heat is the examples of non-mechanical wave. In fact all the electromagnetic waves are non-mechanical.

All the electromagnetic wave consists of photon.

The wavelength range of electromagnetic wave is 10^{-14}m to 10^{4} m.

Properties of electromagnetic waves

1. They are neutral (uncharged).
2. They propagate as transverse wave.
3. They propagate with the velocity of light.
4. They contain energy and momentum.
5. Their concept was introduced by Maxwell.

Following waves are not electromagnetic

1. Cathode rays
2. Canal rays
3. α rays
4. β rays
5. Sound wave
6. Ultrasonic wave

Some Important Electromagnetic Waves & their discoverer

γ-Rays - Henry Becqueral
X-Rays - W. Rontgen
Ultra-violet rays - Ritter
Visible radiation - Newton
Infra-red rays - Hershel
Short radio waves or Hertzian Waves - Heinrich Hertz
Long Radio Waves - Marconi

Note: Electromagnetic waves of wavelength range 10^{-3} m to 10^{-2} m are called microwaves.

Amplitude: Amplitude is defined as the maximum displacent of the vibrating particle on either side from the equilibrium position.

Wavelength: Wavelength is the distance between any two nearest particle of the medium, vibrating in the same phase. It is denoted by the Greek letter **lambda**. (λ)

In transverse wave distance between two consecutive crests or troughs and in longitudinal wave, distance between two consecutive compressions or rarefactions is equal to wavelength.

Velocity of wave = frequency × wavelength.

Time period – The time taken by the vibration of the particles of the medium in completing one oscillation is called Time period.

Frequency – The number of oscillations executed by the particles of the medium in one second is called frequency of wave. Its SI unit is Hertz.

Sound

Sound waves are mechanical longitudinal waves and require medium for their propagation. It cannot propagate through vacuum. when propagated speed and wavelength changes but frequency remains constant. It is of three types:
Infrasonic waves – (0 to 20,000 Hz)
Audible waves – (20 to 20,000 Hz)
Ultrasonic waves – (>20,000 Hz)

Properties of Sound Wave

Reflection

- The bouncing back of sound when it strikes a hard surface, is called reflection of sound.
- The laws of reflection of light are also obeyed during reflection of sound.
- The working of megaphone, sound boards and ear trumpet is based on reflection of sound.
- The repetition of sound due to reflection of sound waves, is called an **echo.**
- The persistence of hearing on human ear is $\frac{1}{10}^{th}$ of a second.
- The minimum distance from a sound reflecting surface to hear an echo is nearly is nearly 17 m.
- Sound proof rooms are made of two layers of walls having vacuum between them.
- **Reverberation** arises due to multiple reflection of sound.
- While designing an auditorium for speech or musical concerts, one has to take proper care for the absorption and reflection of sound.
- Time taken by reverberant sound to decrease its intensity by a factor of 10^6 is called **reverberation time.**

Refraction

- When a sound wave moves from one mechanical medium to another mechanical medium, it shows deviation from the original path of the incident wave. The phenomenon is called refraction. It is due to difference is speed of sound in media.

Diffraction

- When sound waves originated by a vibrating source, they spread in the medium and if the medium is homogeneous, this leads to bending of sound waves around the edges. Which is known as diffraction.
- The sound waves diffracted broadly and one can easily hears the voice of the another person.

Musical Scale

- In theory of music, a musical scale is a set of musical notes by the frequencies of which are in simple ratios to one another. Sa, re, ga, ma, pa, dha, ni is one such scale called the diatonic scale. The frequencies of these notes are: sa (256), re (288), go (320), ma (341.3), pa (384), dha (426.7) and ni (480). The next note denoted by sa has a frequency 512, twice that of sa. The interval sa-sa is called an octave (8).

Noise Reduction in Recording Media

- Five types of noise reduction system exists in recording media as discussed below
  - Dolby A noise reduction system, intended for use in professional recording studios. It provided about 10 dB of broadband noise reduction.
  - Dolby B was developed to achieve about 9 dB noise reduction primarily for cassettes. It was much simpler than Dolby A and therefore less expensive to implement in consumer products.
  - Dolby C provides about 15 dB noise reduction.
  - Dolby SR (Spectral Recording) system is much more aggressive noise reduction approach than Dolby A. Dolby SR is much more expensive to implement than Dolby B or C, but it is capable of providing upto 25 dB noise reduction in the high frequency range.
  - Dolby S is found on some Hi-Fi and semi-professional recording equipment. It is capable of 10 dB of noise reduction at low frequencies and upto 24 dB of noise reduction at high frequencies.

Doppler's Effect

The apparent change in the frequency of source due to relative motion between the source and observer is called Doppler's effect.

Applications of Doppler's Effect

The measurement of Doppler shift (based on Doppler's effect) has been used

- By police to check over speeding of vehicles.
- At airports to guide the aircraft.
- To study heart and blood flow in different parts of the body.
- By astrophysicist to measure the velocities of planets and stars.

SONAR

- SONAR stands for **Sound Navigation and Ranging.** It is used to measure the depth of a sea, to locate the enemy submarines and shipwrecks.
- The transmitter of sonar produces pulses of ultrasonic sound waves of frequency of about 50000 Hz. The reflected sound waves are received by the receiver.

Human Ear

- We are able to hear with the help of an extremely sensitive organ of our body called the ear. There are three parts of human ear
  - The **outer ear** is called **pinna**. It collects the sound from the surroundings. The **middle ear** transmits the amplified pressure variations received from the sound wave to the **inner ear**.
- In the inner ear, the pressure variations are turned into electrical signals by the cochlea. These electrical signals are sent to the brain via the auditory nerve and the brain interprets them as sound.

HEAT

Heat

• Heat is the form of energy which produces the sensation of warmth. Its SI unit is joule and other unit calorie (1 cal = 4.2 Joule) .

• The transfer of heat is always from hotter to colder body.

Temperature

• Temperature is measure of hotness or coldness of a body.

• The heat flows from one body to another due to the difference in their body temperature.

Scale of Temperature

• To measure the temperature of a body following temperature scales are used.

— **Celsius scale** of temperature freezing point is 0°C
Boiling point of water is 100°C

— **Fahrenheit scale** of temperature ice point or freezing of water = 32° F
Boiling point of water = 212° F

— **Kelvin or absolute scale** of temperature ice point of water = 273° K
Boiling point of water = 373° K

— **Reaumur scale** of temperature ice point of water is 0° R,
Boiling point of water = 80°R

— **Rankine scale** of temperature ice point /freezing point of water
= 491.67°R Boiling point of water
= 671.641° R

Relation between Different Scales of Temperature

Different scales of temperature are related as follows:

$$\frac{C}{100} = \frac{F - 32}{180} = \frac{R}{80} = \frac{K - 273}{100}$$

K =273+ °C

• At temperature – 40°C = – 40°F, Clesius scale is equal to Fahrenheit

• The temperature at which the three phases of water remains at equilibrium is called triple point of water (273.16 K)

Thermometers

• The instruments used to measure temperature of a body is called thermometer.

Thermometers are of following three types

1. **Clinical thermometer** It is used to measure human body temperatures and ranges from 96° F to 110°F or 35°C to 43°C.
2. **Electronic thermometer** Basic components of an electronic thermometer are thermistors or thermoresistors. Range of electronic thermometer is –40° to 450°F.
3. **Other thermometers** these include constant volume gas thermometer, platinum resistance thermometer etc.

- Clinical thermometer measures temperature in degree fahrenheit (°F).
- In thermometer, mercury is commonly used through a wide range from –30°C to 300°C.
- Thermometer was developed by **Galileo** who found that the gases expand on heating.

Thermal Expansion

- The expansion of a body caused by heat is known as thermal expansion.

Thermal Expansion of Solids

Thermal expansion of solids is of three types

1. Expansion in length on heating is called **linear expansion**. The increase in length of a rod of unit length of a substance due to increase in its temperature by 1°C is called the **coefficient of linear expansion** of the substance of that rod. It is represented by α.

$$\alpha = \frac{\text{Increase in length}}{\text{Initial length} \times \text{Rise in temperature}} = \frac{\Delta L}{L \times \Delta t}$$

— Its unit is $°C^{-1}$.

2. Expansion in area on heating, is called **superficial expansion**. Coefficient of superficial expansion is given as

$$\beta = \frac{\text{Increase in area}}{\text{Initial area} \times \text{Rise in temperature}} = \frac{\Delta A}{A \times \Delta t}$$

— Its unit is $°C^{-1}$.

3. Expansion in volume on heating, is called **volume expansion** or **cubical expansion**.

Coefficient of volume or cubical expansion is given as

$$\gamma = \frac{\text{Increase in volume}}{\text{Original volume} \times \text{Rise in temperature}} = \frac{\Delta V}{V \times \Delta t}$$

— Its unit is $°C^{-1}$

Relation between Coefficients of Expansions

• Coefficients of thermal expansions are related as
$\beta = 2\alpha$ and $\gamma = 3\alpha$
and $\alpha : \beta : \gamma = 1 : 2 : 3$

• In laying a railway line, a small gap is left in between two iron rails otherwise railway line will become curved on heating in summer.
• Telephone wires are not tighten on poles because in winter, wires get contract and can break.

Thermal Expansion of Liquids

• In liquids, only expansion in volume takes place on heating.

Expansion of liquid is of two types:
• When expansion of the container, containing liquid, on heating, is not taken into account, then observed expansion is called **apparent expansion** of liquids.
• When expansion of the container, containing liquid, on heating, is also taken into account, then observed expansion is called **real expansion** of liquids.
$\gamma_r = \gamma_a + \gamma_g$
where, γ_r and γ_a, are coefficients of real and apparent expansion of liquids and γ_g = coefficient of cubical expansion of the container.

Anomalous Expansion of Water

When temperature of water is increased from 0°C, then its volume decreases up to 4°C, becomes minimum at 4° C and then increases. This behavior of water expansion around 4°C is called, anomalous expansion of water.

Thermal Expansion of Gases

There are two types of coefficient of expansion in gases
— At constant pressure, the change in volume per unit volume per degree celsius is called **volume coefficient** (γ_v).
— At constant volume, the change in pressure per unit, pressure per degree celsius, is called **pressure coefficient** (γ_p).

Calorimetry

- Amount of heat required to raise the temperature of 1 g of water by 1°C is called 1 calorie.
- Calorimetry states that heat lost by hotter body equals the heat gained by colder body.

Specific Heat

- The amount of heat required to raise the temperature of unit mass (m) of a substance through 1°C, is called its specific heat (s).
- It is denoted by s and its unit is 'cal/g°C or Joule/g°/C.
- The specific heat of water is 4200 J/kg^1/°C or 1000 cal/ g^1/° C$^-$, which is high compared with most other substances. Therefore, water is used as coolant in radiator in vehicle and hot water is used for the fermentation.
- Heat energy given or taken to change the temperature of a body is given by
  $Q = ms\Delta\theta$
  Where, m = mass of the body
  and $\Delta\theta$ = change in temperature.
- The amount of heat required to raise the temperature of 1 mole of a gas by 1°C is called molar specific heat.

Latent Heat

- The heat energy absorbed or released at constant temperature per unit mass for change of state, is called **latent heat**.
- It is denoted by L and its SI unit is cal/g or kcal/kg.
- Heat energy absorbed or released during change of state is given by
  $Q = mL$
  where, m = mass of the substance.
- Latent heat of fusion of ice is 80 cal/g.
- Latent heat of vaporisation of steam is 536 cal/g.

Thermodynamics

- The branch of physics which deals with the study of relation of heat energy with different types of energy is called thermodynamics.

Zeroth Law

- Zeroth law of thermodynamics tells about thermal equilibrium.

First Law

- As per first law about energy, heat given to a substance is equal to sum of change in internal energy and work done.

Second Law

- In second law work can be converted into heat and vice-versa but conversion is not possible with 100% efficience.
- It is impossible for a machine operating in a cyclic process to convert heat completely into work, it is **kelvin's statement**.
- Heat by itself can not transfer from a colder to a hotter body. It is **clausius statement**. Refrigerator is based on this statement.
- **Heat engine** is a device which converts heat into mechanical work. Internal combustion and external combustion heat engine are two types of heat engine.

• Car engine uses coolant added with water to reduce harmful effects like corrosion, rusting etc. Such as ethylene glycol, polossium dichromate etc,
• **Carnot's theorem** tells about maximum efficiency of heat engine. It refers to Carnot cycle.

• **Entropy** measures the molecular disorder of a system and is a thermodynamic function depending only on the temperature of the system.

• **Evaporation** is a process in which molecules escape slowly from the surface of a liquid.

- For a given liquid the rate of evaporation demands on the temperature and area of evaporating surface.
- **Refrigerator** is a device used for cooling things by the evaporation and compression of a volatile liquid inside a copper coil.

Humidity

- The presence of moisture in the atmosphere is called humidity.
- The amount of water vapour present in the unit volume of atmosphere is called **absolute humidity**.
- The **relative humidity** of air at a given temperature is the ratio of mass of water vapour present in a certain volume of air to the mass of water vapour required to saturate the same volume of air at the same temperature, multiplied by 100.
- Relative humidity is measured by **hygrometer**.
- Relative humidity of about 50% is considered comfortable at temperature 22° – 25° C.
- If the relative humidity is very low in air, then lips become dry and cracks appear in them.
- If relative humidity is very high in air then the sweat from our body does not evaporate readily and therefore we feel uncomfortable.
- **Air conditioning** provides comfortable conditions by regulating temperature and humidity.

Transmission of Heat

- Heat can be transferred from one place to another by process of transmission.
- There are three methods of transmission of heat.

Conduction

- The mode of transmission of heat in solids from higher temperature part to lower temperature part without actual movement of the particles, is called conduction.
- Transmission of heat in solids takes place mainly through conduction.
- Metals are good conductors of heat.
- Wood, cotton, wool, glass are bad conductors of heat, dry air is also a bad conductor of heat.
- Woollen clothes do not allow the heat of our body to escape and therefore we feel warm.
- On a cold night two thin blankets give more warmth than a single thick blanket because the layer of air between the two blankets works as a better insulator.
- Refrigerators and ice-boxes have double walls having thermocol between them which minimise heat gain by conduction.

Convection

- The mode of transmission of heat in fluids (liquids and gases) due to actual movement of the particles, is called convection.
- In liquids and gases, heat is transmitted by convection.
- When a liquid in a vessel is heated at the bottom, the liquid at bottom gets heated and expands.
- Due to its lower density, hot liquid rises and its place is taken by cold liquid from above. Convection currents are set up in the liquid until the temperature of the whole liquid becomes same.
- The cooling unit in a refrigerator is fitted near the top as cold air move downward and keeps cool the whole interior.
- Radiator in a motor car works on the principle of convection.

Newton's Law of Cooling

The rate of loss of heat from a body is directly proportional to the difference in temperatures of the body and its surroundings.

If we take hot water and fresh water and put it in a refrigerator, then rate of cooling of hot water will be faster than the fresh tap-water.

- **Sea Breeze** During day time, the seashore warms up much faster than sea water. Hot air over the seashore rises and cooler air from sea water moves towards seashore to take its place resulting in a sea breeze.
- **Land Breeze** At night, land cools faster than sea water. Now hot air over sea water rises and cooler air from land moves towards sea to take its place and resulting in a land breeze.
- Cloudy nights are warmer than clear night because clouds reflect the radiations emitted by the earth at night and keep it warm.

Radiation

- The process of heat transmission in the form of electromagnetic waves is called radiation.
- Radiation does not require any medium for propagation and it propagates without heating the intervening medium.

Black Body

- A body that absorbs the entire radiation incident on it is called perfectly black body.
- Ratio of heat absorbed (radiation) to total incident radiation for a body is called absorptive power (a) of body. It has no unit.
- Amount of heat radiation per unit area of the surface at a given temperature is called emissive power of the surface.
- Its unit is $J/m^2 - s$.
- The ratio of emissive power and absorptive power of a body is always same. It is equal to emissive power of a black body. This is known as **Kirchhoff's law**.

- White colour is a bad absorbers and good reflectors of heat radiations while black colour is good absorbers and bad reflectors of heat. Therefore, clothes of light colours give better feeling in summer and clothes of dark colours give better feeling in winter.

Stefan's Law

- It states that "The amount of heat energy (E) radiated per second by unit area of perfectly black body is directly proportional to the fourth power of absolute temperature (T) of the body."
  $E \propto T^4$
- Good absorbers are good emitters and poor absorbers are poor emitters.

MATTER

Matter

Matter is considered as any thing which has weight and occupies space.
It exists in three states: Solid, liquid and gas.
In solid, molecules vibrate about fixed positions.
In liquid, molecules also vibrate but simultaneously they move freely throughout the material. In gas, the molecules are much farther apart than in solids and liquids and move at high velocities.

Interatomic Forces

The electrostatic force of interaction acting between the two or more atoms is called interatomic forces.
The range of interatomic forces is equal to the order of atomic size, i.e. 10^{-10} m.
A force which changes the configuration of a body is called a **deforming force.**

Solid

It is that, state of matter which has definite shape and definite volume. In this state molecules are very closely packed.

Properties of Solids

Elasticity

The property of a body by virtue of which it regain its original configuration after the removal of deforming force, is called elasticity.
Quartz and phosphor bronze are almost perfectly elastic bodies.

Plasticity

The property of a body by virtue of which it doesn't regain its original configuration after the removal of deforming force, is called plasticity.

Strain

The fraction I change in configuration i.e. length, volume and shape, is called strain. Strain has no unit.

On the basis of change in configuration, strain is of three types
- Longitudinal strain = $\frac{\Delta l}{l}$
- Volume strain = $\frac{\Delta V}{V}$
- Shearing strain = θ

Stress

The internal restoring force acting per unit area of cross-section of a deformed body is called **stress.**
Stress is of two types
- Normal stress
- Tangential stress

The maximum deforming force upto which a body retains its property of elasticity is called the limit of elasticity of the material body.
The minimum stress required to break a wire is called breaking stress.
The torque required to produce a given twist in a hollow cylinder is greater than that required to produce the same twist in a solid cylinder. Therefore, hollow shaft is stronger than a solid shaft.
Springs are made of steel, not of copper as Young's modulus of elasticity of steel is more than that of copper.

Elastic Limit

It is the limit of stress and strain upto which a wire remains elastic.

Plastic Behaviour

If the wire is stretched beyond the elastic limit, the strain increases much more rapidly. If the stretching force is removed, the wire does not come back to its natural length.

Fracture Point

If the deformation is increased further the plastic behaviour, the wire breaks at a point known as fracture point.

Ductile and Brittle Materials

If large deformation takes place between the elastic limit and the fracture point, the material is called ductile.
If the wire breaks soon after the elastic limit is crossed, it is called **brittle.**

Elastic Fatigue

It is the property of an elastic body by virtue of which its behaviour becomes less elastic under the action of repeated alternating deforming force. Due to elastic fatigue, the bridges become less elastic after a use of long time and therefore are declared unsafe.

Fluid

A substance which begins to flow under an external force is called a fluid. Liquids and gases are fluids.

Fluid Density
The ratio of mass to the volume of a body is called its density. (i.e. mass present in its unit volume). It is a scalar quantity having SI unit kg/m^3.
The density of water is 1000 kg/m^3.
The density of water is maximum at 4°C.
Hydrometer It is an instrument used to measure density or relative density of liquid. Its working is based on law of floatation.

Pressure – Pressure is defined as the force applied per unit surface area. It is a scalar quantity.
Pressure= Force applied/Area of Surface
The SI unit of Pressure is N/m^2 which is called Pascal.

Fluid Pressure
Thrust (the normal force) exerted by a liquid per unit area of the surface in contact at rest, is called fluid pressure.
Fluid pressure (p) $= \frac{F}{A}$
Its unit is Nm^{-2} or Pascal (Pa).

Atmospheric Pressure
The pressure exerted by the atmosphere, is called atmospheric pressure.
Aneroid barometer is used to measure atmospheric pressure and height of a place.
Other units of atmospheric pressure are torr and bar.

Pascal's Law
The pressure exerted anywhere at a point of confined fluid is transmitted equally and undiminished, in all directions throughout the liquid.
Hydraulic lift, hydraulic press hydraulic brakes works on the basis of Pascal's law.

Buoyancy
When a body is partially or wholly immersed in a liquid, an upward force acts on it, which is called buoyant force or upthrust and this property of fluids is called buoyancy.
Buoyant force is equal to the weight of the liquid displaced by the submerged part of the body.
The buoyant force acts at the centre of gravity of the liquid displaced by the submerged part of the body, which is called 'centre of buoyancy'.

Archimedes Principle
When a body is partially or completely immersed in a liquid, it loses some of its weight. The loss in weight is equal to the weight of the liquid displaced by the submerged part of the body.

Law of Floatation
A body will float in a liquid if weight of the body is equal weight of the liquid displaced by the immersed part of the body.
In floating condition, the centre of gravity (g) and the centre of buoyancy (B) of the floating body must lie on the same straight line.
Ice and large icebergs float on water surface as its density (0.92 g/cm3) is lesser than the density of water.
When a piece of ice floats on water, its $\left(\frac{11}{12}\right) th$ part submerged in water and (1/12) th part is outside the water.
In sea water, (8/ 9) th part of icebergs is submerged and (1/9) th part is outside the water during floating.
It is easier to swim in sea water than in a river as density of sea water is greater than the density of river water. In sea water, buoyant force is greater than that in river water.
The density of human body is less than the density of water but the density of human head is greater than the density of water. Therefore, during swimming a person displaces the liquid with hands and legs and total weight of displaced liquid becomes equal to the weight of the body.

Surface Tension
The property of a liquid by virtue of which it tries to minimise its free surface area is called surface tension.
The minimum surface area of a given amount of liquid is for spherical shape. Therefore, rain drops are spherical.
Surface tension of a liquid becomes zero at critical temperature.

Factors Affecting Surface Tension
- **Temperature** The surface tension of a liquid decreases with increase in temperature.
- **Soluble Impurities** If the impurities are less soluble in liquid, then its surface tension decreases. If impurities are highly soluble in liquid, then its surface tension increases.

Applications of Surface Tension

- When soap, detergent, dettol, phenyl etc., are mixed in water then its surface tension decreases.
- When salt is added in water, its surface tension increases.
- When oil spreads over the surface of water, its surface tension decreases.
- When kerosene oil is sprinkled on water, its surface tension decreases. As a result, the larva of mosquitoes floating on the surface of water dies due to sinking.
- Warm soup is tasty because at high temperature its surface tension is low and consequently the soup spreads on all parts of the tongue.
- Antiseptics like dettol have low surface tension and therefore it reaches in the tiny cracks of the wound and cleans the germs and bacteria.
- The surface tension of soap solution in water is less than the surface tension of pure water. Therefore, soap solution cleans greasy strains of clothes better than pure water.

Capillarity

The phenomenon of rising or falling of liquid column in a capillary tube (glass tube of very fine bore) is called capillarity.

Illustrations of capillarity

1. A piece of blotting paper soaks ink because the pores of the blotting paper serve as capillary tubes.
2. The oil in the wick of a lamp rises due to capillary action of threads in the wick.
3. The root hairs of plants draw water from the soil through capillary action.
4. To prevent loss of water due to capillary action, the soil is loosened and split into pieces by the farmers.
5. If a capillary tube is dipped in water in an artificial satellite, water rises up to other end of tube because of its zero apparent weight, how long the tube may be.
6. Action of towel in soaking up water from the body is due to capillary action of cotton in the towel.
7. Melted wax, in a candle rises up to wick by capillary action.

Cohesive and Adhesive Forces

The intermolecular force of attraction acting between the molecules of same substance is called **cohesive force.**

e.g., Intermolecular force of attraction acting between the molecules of water, mercury etc.

The intermolecular force of attraction acting between the molecules of different substance is called **adhesive force.**

e.g., Intermolecular force of attraction acting between the molecules of paper and gum, paper and ink, etc.

Viscous force: The force which opposes the relative motion between different layers of liquid or gases is called viscous force.

Viscosity: Viscosity is the property of a liquid by virtue of which it opposes the relative motion between its different layers.

- Viscosity is the property of liquids and gases both.
- The viscosity of a liquid is due to cohesive force between its molecules.
- The viscosity of a gas is due to diffusion of its molecules from one layer to other layer.
- Viscosity of gases is much less than that of liquids. There is no viscosity in solids.
- Viscosity of an ideal fluid is zero.
- With rise in temperature, viscosity of liquids decreases and that for gases increases.
- Viscosity of a fluid is measured by its coefficient of viscosity. Its SI unit is decapoise (kg/ms) or pascal second. It is generally denoted by η.

Stoke's Law

According to this law, the viscous force depends upon the coefficient of viscosity, velocity of the moving object and its size.

Terminal Velocity

When a small spherical body falls through a long liquid column its velocity increases gradually but later on it becomes constant, called terminal velocity.

The radius of spherical rain drops is very small therefore their terminal velocity is also small, with which they strike the earth's surface. When a liquid flow through a pipe, its speed is maximum near axis and minimum near the walls of the pipe.

Equation of Continuity

When a non-viscous liquid flows through a pipe of non-uniform cross-sectional area in stream-lined flow, (i.e. velocity at every point in the fluid remains constant) then at each section of the tube, the product of area of cross-section of the pipe and velocity of liquid remains constant, i.e. $A \times v$ = constant.

Therefore speed (v) of fluid flow becomes faster in narrower pipe.

Bernoulli's Theorem
If a non-viscous and incompressible liquid is flowing in stream-lined flow then total energy, i.e., sum of pressure energy, kinetic energy and potential energy, per unit volume of the liquid remains constant.
Venturi tube and aspirator pump works on Bernoulli's theorem.
According to Bernoulli's theorem, with increase in velocity of quid its pressure decreases and vice-versa.
During storms or cyclones, the roofs of the huts or tinned roofs blown off because wind blows with very high speed over the top of the roof and therefore pressure of air decreases. Due to the pressure difference of air above and below the roof, a lifting force acts on the roof. If it is sufficient to balance the weight of the roof it starts to fly off.
Magnus Effect: Motion of a Spinning Ball
When swing bowlers deliver the ball, the ball changes its plane of motion in air.

LIGHT

REFLECTION OF LIGHT (Law of Reflection)
(i) The angle of incidence is equal to the angle of reflection
(ii) The incident ray, the normal to the mirror at the point of incidence and the reflected ray, all lie in the same plane

Spherical Mirrors & their Uses

Uses of concave mirrors
Concave mirrors are commonly used in torches, search-lights and vehicles headlights to get powerful parallel beams of light.
They are often used as shaving mirrors to see a larger image of the face. The dentists use concave mirrors to see large images of the teeth of patients.
Large concave mirrors are used to concentrate sunlight to produce heat in solar furnaces.

Uses of convex mirrors
Convex mirrors are commonly used as rear-view (wing) mirrors in vehicles, enabling the driver to see traffic behind him/her to facilitate safe driving. They always give an erect, though diminished, image. Also, they have a wider field of view as they are curved outwards. Thus, convex mirrors enable the driver to view much larger area than would be possible with a plane mirror.

REFRACTION OF LIGHT
when a thick glass slab is placed over some printed matter, the letters appear raised when viewed through the glass slab the bottom of a tank or a pond containing water appears to be raised seen a pencil partly immersed in water in a glass tumbler. It appears to be displaced at the interface of air and water
A lemon kept in water in a glass tumbler appears to be bigger than its actual size, when viewed from the sides.

The following are the laws of refraction of light.
(i) The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.
(ii) The ratio of sine of angle of incidence to the sine of angle of refraction is a constant, for the light of a given colour and for the given pair of media. This law is also known as Snell's law of refraction.
If i is the angle of incidence and r is the angle of refraction, then,
Sin i/Sin r = constant

The one with the larger refractive index is optically denser medium than the other. The other medium of lower refractive index is optically rarer. The speed of light is higher in a rarer medium than a denser medium
The light from the Sun constitutes parallel rays of light. These rays were converged by the lens at the sharp bright spot formed on the paper. In fact, the bright spot you got on the paper is a real image of the Sun. The concentration of the sunlight at a point generated heat. This caused the paper to burn.

REFRACTION OF LIGHT THROUGH A PRISM
DISPERSION OF WHITE LIGHT BY A GLASS PRISM

The prism has probably split the incident white light into a band of colours. The sequence of colours VIBGYOR. The splitting of light into its component colours is called dispersion.

Different colours of light bend through different angles with respect to the incident ray, as they pass through a prism. The red light bends the least while the violet the most. Thus the rays of each colour emerge along different paths and thus become distinct.It is the band of distinct colours that we see in a spectrum.

A rainbow is a natural spectrum appearing in the sky after a rain shower. It is caused by dispersion of sunlight by tiny water droplets, present in the atmosphere. A rainbow is always formed in a direction opposite to that of the Sun. The water droplets act like small prisms. They refract and disperse the incident sunlight, then reflect it internally, and finally refract it again when it comes out of the raindrop. Due to the dispersion of light and internal reflection, different colours reach the observer's eye.

ATMOSPHERIC REFRACTION
The air just above the fire becomes hotter than the air further up. The hotter air is lighter (less dense) than the cooler air above it, and has a refractive index slightly less than that of the cooler air.Since the physical conditions of the refracting medium (air) are not stationary, the apparent position of the object, as seen through the hot air, fluctuate. This wavering is thus an effect of atmospheric refraction (refraction of light by the earth's atmosphere).

Twinkling of stars

The twinkling of a star is due to atmospheric refraction of starlight.

The starlight, on entering the earth's atmosphere, undergoes refraction continuously before it reaches the earth. The atmospheric refraction occurs in a medium of gradually changing refractive index. Since the atmosphere bends starlight towards the normal, the apparent position of the star is slightly different from its actual position. As the path of rays of light coming from the star goes on varying slightly, thestarlight entering the eye flickers – the star sometimes appears brighter, and at some other time, fainter, which is the twinkling effect.

Advance sunrise and delayed sunset

The Sun is visible to us about 2 minutes before the actual sunrise, and about 2 minutes after the actual sunset because of atmospheric refraction. The time difference between actual sunset and the apparent sunset is about 2 minutes.

SCATTERING OF LIGHT

The blue colour of the sky, colour of water in deep sea, the reddening of the sun at sunrise and the sunset.

Why is the colour of the clear Sky Blue?

The red light has a wavelength about 1.8 times greater than blue light. Thus, when sunlight passes through the atmosphere, the fine particles in air scatter the blue colour (shorter wavelengths) more strongly than red. The scattered blue light enters our eyes. If the earth had no atmosphere, there would not have been any scattering. Then, the sky would have looked dark. The sky appears dark to passengers flying at very high altitudes, as scattering is not prominent at such heights.

Total Internal Reflection

a)mirage – Desert e.g.

Hotter air is less dense, and has smaller refractive index than the cooler air. On hot summer days, the air near the ground becomes hotter than the air at higher levels noticed that while moving in a bus or a car during a hot summer day, a distant patch of road, especially on a highway, appears to be wet. This is also due to mirage.

b) Diamonds - Their brilliance is mainly due to the total internal reflection of light inside them.

c) Optical fibres too make use of the phenomenon of total internal reflection.Light undergoes repeated total internal reflections along the length of the fibre there is no appreciable loss in the intensity of the light signal.

Tyndall Effect

The earth's atmosphere is a heterogeneous mixture of minute particles like smoke, tiny water droplets, suspended particles of dust and molecules of air.When a beam of light strikes such fine particles, the path of the beam becomes visible. When a fine beam of sunlight enters a smoke-filled room through a small hole. Tyndall effect can also be observed when sunlight passes through a canopy of a dense forest.

The colour of the scattered light depends on the size of the scattering particles. Very fine particles scatter mainly blue light while particles of larger size scatter light of longer wavelengths.

MAGNETISM AND ELECTRICITY

Electricity — Flow of Electrons is called Electricity

- The electricity produced by friction between two appropriate bodies, is called static electricity, it is also called **frictional electricity.**

Coulomb's law:-

- The electrostatic force of interaction acting between two stationary point charges is directly proportional to the product of magnitude of charges and inversely proportional to the square of the distance between them.

  $F=(Kq_a-q_b)/r2$

Electric Field

- The space in the surrounding of any charge in which its influence can be experience by other charge, is called electric field.

- **Electric field intensity (E)** at any point is defined as the electrostatic force **(F)** acting per unit positive test charge (q) at the point.
- $E = \frac{F}{q}$
- Its unit is newton/coulomb.
- Therefore, electric field intensity is inversely proportional to the square of the distance r from the point charge.

Electric Field Lines

- An **electric field line** is an imaginary line, so that its tangent at any point is in the direction of the electric field vector at that point.
- Two lines can never intersect. Electric field lines always begin on a positive charge and end on a negative charge and do not start or stop in mid-space.

Electric Potential

- **Electric potential** at a point in an electric field is equal to the work done per unit charge in carrying a test charge from infinity to that point. Its unit is joule/coulomb.
- Electric potential, V = $\frac{W}{q}$.
- Potential difference is that physical quantity which decides the direction of flow of charge between two points in electric field.
- Positive charge always tends to move from higher potential towards lower potential.

Electric Dipole and Capacitor

- An **electric dipole** consists of two equal and opposite point charges separated by a very small distance.
- **Electric dipole moment** of the dipole is product of charge and the separation between the charges.
- A **capacitor or condenser** is a device over which a large amount of charge can be stored without changing its dimensions.
- The **capacitance** of a conductor is equal to the ratio of the charge (q) given to the conductor to change in its potential (V) is given by C = $\frac{q}{V}$
- Its unit is coulomb/volt or farad. Farad (F) is a large unit of capacitance. Its practical unit is microfarad (μF).
- $1\mu F = 10^{-6} F$

Type of Materials

- **Conductors** are those type of materials which have number of free electrons to conduct the electricity. The metals are good conductors of electricity.
- **Insulators** are that type of materials which do not have the free electrons in its volume and hence, it does not conduct the electricity at all.
- **Semiconductor** is that type of materials which do not have free electrons at the normal temperature, but has the free electrons at the increased temperature and hence, behaves like a conductor. The materials such as silicon, germanium etc., are the semiconductor.

Electric Current

- An electric current whose magnitude and direction do not change with time is called direct current, and whose magnitude changes continuously and direction changes periodically is called alternating current.
- Inverter is a device which converts DC to AC.
- In solid conductors, electric current flows due to flow of electrons, in liquids due to flow of ions as well as electrons and in semiconductors due to flow of electrons and holes.
- **Its S.I. unit is Ampere**

Resistance

- Resistance is the opposition that a substance offers to the flow of electric current.
- It is represented by R.
- **Its S.I. unit is ohm.**

Conductance

- **Conductance and conductivity** is the reciprocal of resistance and the resistivity of the material respectively. The SI unit of conductance is Ω^{-1} i.e., mho and to that of conductivity is $\Omega^{-1}m^{-1}$.

Resistivity

- Resistivity of a material depends on the temperature and nature of the material depends on temperature and nature of the material. It is independent of dimensions of the conductor, i.e., length, area of cross-section etc.
- Resistivity of metals increases with increase in temperature.

Combination of Resistances

- It resistance R_1, R_2 and R_3 are connected in **series,** then their equivalent resistance is given by $R = R_1 + R_2 + R_3$
- In series combination, equal current flows through each resistors but Voltage vauies
- If resistances R_1, R_2, R_3 are connected in **parallel**, then their equivalent resistance is given by
- $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
- In parallel combination, potential difference across each resistor remains same but current varies.

Ohm's law

- It states that if physical conditions of any conductor such as temperature, pressure etc., remain unchanged, then electric current (I) flowing through it is directly proportional to the potential difference (V) applied across its ends, i.e.,
- I ∝ V or V = IR where, R is the electrical resistance of the conductor.

Electric Cell

- An electric cell is a device which converts chemical energy into electrical energy.
- Electric cell are of two types
  —**Primary cell** cannot be charged. Voltaic, Daniell and Leclanche cells are primary cells.
  —**Secondary cell** can be charged again and again. Acid and alkali accumulators are secondary cells.
- Working of electric cells is based on chemical effect of electric current.

Emf of a Cell

- The work done by the cell to bring a (+)ve charge from its own terminal to the other is known as its emf (electromotive force). Electromotive force is work but not a force.

Joule's Law of Heating

- Current can produce three effects: heating effect, magnetic effect and chemical effect.
- Heat is produced in conductor in time t is given by
  $$H = I^2Rt = \frac{V^2}{R}t = VIt$$
- This is known as **Joule's law of heating.**
- Electric bulb, electric kettle, heater etc., devices work on the basis of heating effect of electric current.

- To protect the domestic appliances from sudden change in electricity, fuses are used. It is made of tin, lead, alloy (63% + 37%).
- It should have high resistance and low melting point always connected in series.

Electric power
- The electrical energy produced or consumed per unit time is called electric power.
- Electric power, P = VI = $I^2R = \frac{V^2}{R}$
- 1 kWh = 3.6 × 10^6 J

Chemical Effect of Electric Current
- When an electric current is passed through an acidic or basic solution, it decomposes into its positive and negative ions. The positive ions collect at negative electrode (cathode) and the negative ions collect at positive electrode (anode).
- This phenomenon is called electrolysis. It is chemical effect of current. The process of coating of a base metal with a layer of more expensive metal, is called **electroplating**.

Domestic Electrification
- From the distribution, the two terminals are supplied to the houses named as live and neutral (neutral is earthed at local substation). The third terminal is introduced as the earth for the safety in the building.

Lightning Appliance
- The electric discharge occurring between two charged clouds or between a charged cloud and earth can damage the houses or buildings. To protect this lightning conductors are used.

Magnetism
- **Magnet**
- A magnet is a material which can attract iron objects.
- A natural magnet is an ore of iron (Fe_3O_4) called magnetite or lodestone.
- A magnet which is prepared artificially is called an **artificial magnet**.
- A freely suspended magnet always aligns itself into North-South direction. Like magnetic poles repel and unlike magnetic poles attract each other.
- A current-carrying coil containing a soft iron core is called an **electromagnet.**
- An electromagnet is utilised in electric bell, telegraph receiver, telephone diaphragm, transformer, dynamo etc.
- Permanent magnets are made of steel and temporary magnet or electromagnets are made of soft iron because steel cannot magnetised easily but when it is magnetised one time, cannot be demagnetised easily. The soft iron can be magnetised or demagnetised easily.

Properties of Magnet
- **Attractive property** A magnet can attract small pieces of magnetic substances like iron, steel, cobalt, nickel etc. The attraction is maximum at poles. Unlike poles attract and like poles repel.
- **Directive property** A magnet, when suspended freely, aligns itself approximately along geographical N-S line.
- **Magnetic poles exist in pairs** If a magnet is cut into two equal parts transverse to its length, then N and S-poles of the magnet do not get separated.

Magnetic Field
- The space in the surrounding of a magnet or a current carrying conductor, in which its magnetic effect can be experienced, is called magnetic field.
- **Magnetic lines of force** is an imaginary line drawn in magnetic field at which a magnetic North pole will move, if it is free to do so.
- A tangent drawn at any point of a magnetic line of force represents the direction of magnetic field at that point.
- The **magnetic flux** linked with a surface is equal to the total number of magnetic lines of force passing through that surface normally. Its unit is weber.

Earth's Magnetism
- The earth has its own magnetic field. The pole near the geographic North of the earth is called the magnetic North pole. Similarly, the pole near the geographic South pole is called the magnetic South pole.
- The Earth's magnetic field diverts charged particle coming from space towards its poles and saves living beings from being severely harmed.
- **Magnetic compass** A magnetic needle which always direct in North-South (N-S) direction.

Magnetic storm
- Local disturbances in the earth's magnetic field which can damage telecommunication which are probably caused by lump of charged particles emanating from the sun are known as magnetic storm.

Example: In the Arctic Circle, they are known as aurora borealis or the northern lights, while in the Antarctic Circle they are called aurora australis or the southern lights. **Moving Coil Galvanometer**
- A moving coil galvanometer is used to detect the presence of current and the direction of current in any circuit.

Ammeter and Voltmeter
- An ammeter is an instrument used to measure electric current. It is always connected in series. The resistance of an ideal ammeter is zero.

- A **galvanometer** can be converted into an ammeter by connecting a low resistance in parallel.
- A voltmeter is a device used to measure potential difference between two points in an electric circuit.
- The resistance of an ideal voltmeter is infinity. It is always connected in parallel.
- A galvanometer can be converted into a voltmeter by connecting a high resistance in series.
- A small resistance connected in parallel with the load resistance to reduce amount of electric current through resistor is called shunt.

Magnetic Substances

- There are three types of magnetic substances Paramagnetic, Diamagnetic and Ferromagnetic.
- **Paramagnetic Substances**
- Those substances which are feebly magnetised in the direction of magnetic field when placed in strong magnetic field are called **paramagnetic substances.**
- For examples—Aluminium, platinum, chromium, manganese, solutions of salts of iron, nickel, oxygen etc.
- These substances are attracted towards strong magnetic field in a non-uniform magnetic field.
- The magnetism of these substances decreases with increase in temperature.

Diamagnetic Substances

- Those substances which are feebly magnetised in the opposite direction of magnetic field when placed in strong magnetic field are called diamagnetic substances.
- For examples— Gold, silver, zinc, copper, mercury, water, alcohol, air, hydrogen etc.
- These substances are attracted towards weak magnetic field in a non-uniform magnetic field.
- The magnetism produced in these substances does not change with increase or decrease in temperature.

Ferromagnetic Substances

- Those substances which are strongly magnetised in the direction of magnetic field when placed in it, are called ferromagnetic substances.
- For examples —Iron, nickel, cobalt etc.
- The magnetism produced in these substances decreases with increase in temperature and at a particular temperature, called Curie temperature.
- At the **Curie temperature**, a paramagnetic substance becomes diamagnetic.
- Curie temperature for iron is 770°C and for nickel is 358°C.

Electromagnetic Induction (EMI)

- Whenever the magnetic flux linked with an electric circuit changes, an emf is induced in the circuit. This phenomenon is called electromagnetic induction.

Faraday's Laws of EMI

- Whenever the magnetic flux linked with a circuit changes, an induced emf is produced in it.
- The induced emf loses as long as the change in magnetic flux continues.

Lenz's Law

- The direction of induced emf or induced current is always in such a way that it opposes the cause due to which it is produced.

Eddy Current

- If a piece of metal is placed in a varying magnetic field or rotated with high speed in a uniform magnetic field, then induced current set up in the piece is like whirlpool of air, called eddy current, also known as **foucault's current.**

Uses

- Eddy currents are used in dead beat galvanometer, induction furnaces, induction motor, speedometers of automobiles etc.
- Eddy currents are used in diathermy for deep heat treatment of the human body.

Self and Mutual Induction

- The phenomenon of production of induced emf in a circuit due to change in current flowing in its own, is called **self induction.**
- The unit of self induction is Henry (H).
- The phenomenon of production of induced emf in a circuit due to change in magnetic flux in its neighbouring circuit, is called **mutual induction.**
- Its unit is Henry (H).

Alternating Current

- An electric current whose magnitude and direction changes continuously is called alternating current.
- The frequency of alternating current in India is 50 Hz.

Mean or average value of AC is zero for one complete cycle.

- **Root mean square value** of AC is given by
- $I_{rms} = \frac{I_0}{\sqrt{2}}$
- An AC ammeter and AC voltmeter read root mean square value of alternating current and alternating voltage respectively.

AC Generator or Dynamo

- It is a device which Inverts mechanical energy into alternating current.
- Its working is based on electromagnetic induction.

DC Motor

- It is a device which converts electrical energy into mechanical energy.
- Its working is based on the fact that when a current carrying coil is placed in uniform magnetic field, a torque acts on it.

Transformer

- It is a device which can change a low voltage current into a high voltage current and vice-versa.
- Its working is based on mutual induction.

Step-up Transformer

- It converts a low voltage current into a high voltage current.
- The main energy losses in a transformer are given below
- —Iron loss —Flux loss
- —Hysteresis loss —Humming loss (ohmic loss)

Step–down Transformer

- It converts a high voltage current into a low voltage current.

NUCLEAR REACTOR

A nuclear reactor is a device that contains and controls sustained nuclear chain reactions.In nuclear reactors, the nuclear fission is controlled by controlling the number of neutrons released during the fission.The energy liberated in a controlled manner is used to produce steam, which can run turbines and produce electricity.

Fuel - (uranium 235, Plutonium-239)
The fissionable material is used in the reactor along with a small neutron source.The solid fuel is made into rods and is called fuel rods.

Role of extra neutron -
These neutrons in turn can initiate fission processes, producing still more neutrons, and so on. This starts a chain reaction. Slow neutrons (thermal neutrons) are much more likely to cause fission in $^{235}U_{92}$ than fast neutrons. Fast neutrons liberated in fission would escape instead of causing another fission reaction.
If the chain reaction is uncontrolled, it leads to explosive energy output, as in a nuclear bomb or Atom bomb. Each time an atom splits, it releases large amounts of energy in the form of heat.

Moderators -(water, heavy water (D2O) and graphite)
Light nuclei called moderators are provided along with the fissionable nuclei for slowing down fast neutrons.

Core - The core of the reactor is the site of nuclearfission. It contains the fuel elements in suitably fabricated form.

Reflector-The core is surrounded by a reflector to reduce leakage. The energy (heat) released in fission is continuously removed by a suitable coolant.

Coolant - (water, heavy-water, liquid sodium, helium, Liquid oxygen)
The coolant transfers heat produced during fission to a working fluid which in turn may produce steam. The steam drives turbines and generates electricity.

Control rods- (cadmium, Boron)
The reactor can be shut down by means of rods (made of, for example, cadmium, Boron) that have high absorption of capacity of neutrons.cadmium and boron can absorb neutrons to form the corresponding isotopes, which are not radioactive.

Shield - The whole assembly is shielded with heavy steel or concrete to check harmful radiation from coming out.

WORK, POWER AND ENERGY

Work, Energy and Power
Work- The work done by the force is defined as the product of magnitude of force and distance through which particles moves.
Work is a scalar quantity. Its SI unit is joule and CGS unit is erg. 1 joule = 10^7 erg.
Work done by a force is zero when
-Body is not displace actually, i.e. s = 0
-Body is displaced perpendicular to the direction of force i.e. θ = 90°.

Work done by a variable force
If we throw a ball upward, work done against gravity is given by, W = mgh
where, m = mass of the body,
g = acceleration due to gravity and
h = height through which the ball is raised.

The centripetal force acts on a body perpendicular to the direction of motion. Therefore, work done by or against centripetal force in circular motion is zero.
If a coolie is carrying a load on his head and moving on a horizontal platform, then work done by force of gravity is zero as displacement is perpendicular to the direction of force of gravity.

Power- The rate at which work is done is called Power.
Power (P) = Work done/ time interval = W/t.
The SI unit of Power is Watt. The Power of machines is expressed in Horse power (HP).

Energy
Energy of a body is its capacity of doing work. It is a scalar quantity and its SI unit is joule.
Energy can be transformed into work and vice-versa with the help of some mechanical device.
There are two types of Mechanical Energy, which are as follows

Kinetic Energy
The energy possessed by a body by virtue of its motion is called its kinetic energy.
Kinetic energy of the body of mass m moving with velocity v is given by K = $\frac{1}{2}mv^2$.

Potential Energy
The energy possessed by any object by virtue of its position or configuration is called its potential-energy.
Gravitational potential energy, U = mgh

Einstein's Mass-Energy Relation
According to this relation, the mass can be transformed into energy and vice-versa.
When Δm mass is disappeared, then produced energy
E= Δmc^2
where, c = speed of light in vacuum.

Conservative and Non-conservative forces
Conservative forces are non-dissipative forces like gravitational force, electrostatic force etc.
For the conservative forces, work done during a round trip is always zero.
Non-conservative forces are dissipative in nature like frictional force, viscous force etc.

Law of Conservation of Energy
Energy can neither be created nor be destroyed; only one type of energy can be transformed into other form of energy.
Only for conservative forces, (total mechanical energy) initially = (total mechanical energy) finally

Some Equipments used to Transform Energy

S.	Equipment	Energy Transformed
1.	Dynamo	Mechanical energy into electrical energy
2.	Candle	Chemical energy into light and heat energy.
3.	Microphone	Sound energy into electrical energy.
4.	Loud Speaker	Electrical energy into sound energy.
5.	Solar Cell	Solar energy into electrical energy.
6.	Tube light	Electrical energy into light energy.
7.	Electric Bulb	Electrical energy into light and heat energy.
8.	Battery	Chemical energy into electrical energy.
9.	Electric motor	Electrical energy into mechanical energy.
10.	Sitar	Mechanical energy into sound energy.

Collision
Collision between two or more particles is the interaction for a very short interval of time in which they apply relatively strong forces on each other. For a collision, physical contact of two bodies is not necessary.

A collision, in which momentum of the system as well as kinetic energy of the system remains conserved, is called an elastic collision. In an elastic collision, all involved forces are conservative forces.

A collision in which only momentum remains conserved but kinetic energy of the system does not remain conserved, is called an **inelastic collision.**

If after collision two colliding bodies gets sticked with each other and moves with a common velocity, then collision is said to be **perfectly inelastic**.
In perfectly inelastic collision, the loss of kinetic energy during collision does not recover at all and two bodies stick together after collision.

Gravitation
Each and every massive body attracts each other by virtue of their masses. This phenomenon is called gravitation.

Newton's Law of Gravitation
The gravitational force acting between two point objects is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.
Gravitational force (F) = $\frac{Gm_1m_2}{r^2}$

where, G is universal gravitational constant.
Its value is 6.67 $\times 10^{-11} N-m^2 kg^{-2}$.
Gravitational force is a central as well as conservative force.

Acceleration Due to Gravity of Earth
The uniform acceleration produced in a freely falling body due to the earth's gravitational pull, is called acceleration due to gravity, g = $\frac{GM}{R^2}$
where, M = mass of the earth, R = radius of the earth.
The value of g changes slightly from place to place but its value near the earth's surface is 9.8 ms^{-2}.
Gravitational force is the weakest force in nature. It is 10^{36} times smaller than electrostatic force and 10^{38} times smaller than nuclear force.

Factors Affecting Acceleration due to Gravity
Shape of Earth Earth is not completely spherical its radius at equator is approximately 42 km greater than its radius at poles.
The value of g is maximum at poles and minimum at equator.
There is no effect of rotation of the earth at poles and maximum at equator.
Effect of Altitude Therefore, g decreases with altitude.
Effect of Depth g decreases with depth and becomes zero at centre of the earth.

Mass and Weight
The mass of a body is the quantity of matter contained in it. It is a scalar quantity and its SI unit is kg.
Mass is measured by an ordinary equal arm balance.
Mass of a body does not change from place to place and remains constant.
The weight of a body is the force with which it is attracted towards the centre of the earth. Weight of a body (w) = mg
The centre of gravity of a body is that point at which the whole weight of the body appears to act.
The centre of gravity of a body can be inside the material of the body or outside it.
It is a vector quantity and its SI unit is newton (N). It is measured by a spring balance.
Weight of a body is not constant; it changes from place to place.

Weight of a Body in a Lift
When lift is rest or in uniform motion The weight recorded in spring balance (i.e. apparent weight) is equal to the real weight of the body w = mg.
When lift is accelerating upward The weight recorded in spring balance is greater than then real weight of the body w′ = m(g + a)
When lift is accelerating downward The weight recorded in spring balance is smaller than the real weight of the body w′ = m(g – a).
When lift is falling freely under gravity The apparent weight of the body
w' = m (g – g) $(\because a = g)$
w′ = 0
Therefore, bodies will experiences weightlessness.

Weight of a Body at the Moon
As mass and radius of moon is lesser than the earth, so the force of gravity at the moon is also less than that of the earth. It's value at the moon's surface is $\frac{g}{6}$.

Satellite
A heavenly body revolving around a planet in an orbit is called a satellite. Moon is a natural satellite of the earth. The satellite may be artificial. Artificial satellites are of two types.

Geostationary Satellites
It revolves around the earth in equatorial orbits which is also called Geostationary or Geosynchronous orbit. The time period of these satellites is 24 hour.

Polar Satellites
These satellites revolve around the earth in polar orbits at a height of approximately 800 km.
Weather monitoring which is predicted on the basis of information about moisture present in air, atmospheric pressure etc, obtained through a **polar satellite.**
We are able to see a live telecast of cricket world cup match or other programme with the help of a communication satellite which is a geostationary satellite.
Launching vehicles – PSLV & GSLV

Time Period of a Satellite
It is the time taken by a satellite to complete one revolution.
If satellite is near the earth's surface, then T = $2\pi\sqrt{\frac{R}{g}} \approx$ 84.6 min.

Escape Velocity
Escape velocity: Escape velocity is that minimum velocity with which a body should be projected from the surface of earth so as it goes out of gravitational field of earth and never return to earth.

Escape velocity is independent of the mass, shape and size of the body and its direction of projection.
Escape velocity is also called second cosmic velocity.
For earth, escape velocity = 11.2 km/s.
For moon, escape velocity = 2.4 km/s.

Orbital Velocity
Orbital velocity of a satellite $V_0 = \sqrt{gR}$ and escape velocity $V_e = \sqrt{2gR}$ where R = Radius of earth. i.e. $V_e = \sqrt{2}V_0$ i.e. escape velocity is $\sqrt{2}$ times the orbital velocity.
There if the orbital velocity of a satellite is increased to $\sqrt{2}$ times (increased by 41%), the satellite will leave the orbit and escape.

Kepler's Law of Planetary motion – Kepler gave three laws regarding motion of the planets. They are:

- **First Law-** Also known as Law of Orbits. According to this law "Each planet move in an elliptical orbit around the sun, the sun being at one of the foci of the ellipse".
- **Second Law –** According to this law "A line that connects a planet to the sun sweeps out equal areas in equal times. This law is also known as law of areas".
- **Third Law –** It states that "the square of the period of any planet is proportional to the cube of the semimajor axis of its orbit".

CHEMISTRY

CHEMISTRY- Chemistry is the study of the structure of substances and of the way that they react with other substances.

MATTER AND ITS NATURE

On the basis of Chemical composition, matter is divided into:

- **Element –** An element is a substance which is formed by two or more identical molecules. For e.g. Hydrogen, Copper etc.
  They can be classified into – Metal, Non-metal and Metalloids.
- **Compound** – A compound is a substancecomposed of the atoms of two or more elements combined in a definite proportion by weight. For e.g. Water, Sugar etc.
- **Mixture –** A mixture is a substance composed of two or more compounds or elements in any proportion by weight. For e.g. Milk, Cement etc.

Types of mixture:

- **Homogenous Mixture –** When a mixture has same composition throughout than it is known as Homogenous Mixture. For e.g. Alloys and Solutions.
- **Hetrogenous Mixture –** A mixture which does not have uniform properties and composition. It can be clearly separated by boundaries. For e.g. Colloids, Emulsions or Suspensions.

Separation of mixture: Various methods used for separation of components of mixture are as follows:

- Crystallization
- Sublimation
- Distillation

- Matter can exist in three states-
  I. Solid
  II. Liquid
  III. Gas.
- The forces of attraction between the particles (inter-molecular force) are maximum in solids, intermediate in liquids and minimum in gases. The spaces in between the constituent particles and kinetic energy of the particles are minimum in the case of solids, in liquids and maximum in gases.
- The states of matter are inter-convertible. The state of matter can be changed by changing temperature or pressure.
- The process of melting, that is, change of solid state into liquid state is also known as fusion.
- Evaporation is a surface phenomenon. Particles from the surface gain enough energy to overcome the forces of attraction present in the liquid and change into the vapour state. The rate of evaporation depends upon the surface area exposed to the atmosphere, the temperature, the humidity and the wind speed. Evaporation causes cooling.
- Burning of coal, wood or leaves is a chemical change. Explosion of a firework is a chemical change. If you leave a piece of iron in the open for some time, it acquires a film of brownish substance. This substance is called rust and the process is called rusting. The process of rusting can be represented by the following equation: Iron (Fe) + Oxygen (O_2, from the air)water (H_2O) rust (iron oxide-Fe_2O_3) For rusting, the presence of both oxygen and water (or water vapour) is essential. It is a chemical change.
- Prevent iron articles from coming in contact with oxygen, or water, or both. One simple way is to apply a coat of paint or grease. Another way is to deposit a layer of a metal like chromium or zinc on iron. This process of depositing a layer of zinc on iron is called galvanisation.
- Stainless steel is made by mixing iron with carbon and metals like chromium, nickel and manganese. It does not rust.

PROPERTIES OF GASES

1. Properties of Gases

- Gas has no definite volume or shape.
- The other outstanding characteristic of gases is their low densities, compared with those of liquids and solids.
- All gases expand equally due to equal temperature difference.
- **Diffusion of gases:** The phenomenon in which a substance mixes with another because of molecular motion, even against gravity- is called diffusion.
- **The pressure of a gas:** The molecules of a gas, being in continuous motion, frequently strike the inner walls of their container
- Temperature and Temperature Scales: Temperature is defined as the measure of average heat. Temperature is independent of the number of particles or size and shape of the object.

- **Compressibility:** Particles of a gas have large intermolecular spaces among them. By the application of pressure much of this space can be reduced and the particles be brought closer. Hence the volume of a gas can be greatly reduced. This is called compressing the gas.

Gas Laws

- All gases, irrespective of their chemical composition, obey certain laws that govern the relationship between the volume, temperature and pressure of the gases. A given mass of a gas, under definite conditions of temperature and pressure, occupies a definite volume.
  When any of the three variables is altered, then the other variables get altered. Thus these Gas laws establish relationships between the three variables of volume, pressure and temperature of a gas.
- **Boyle's Law:** "The product of the volume and pressure of a given mass of dry gas is constant, at constant temperature".
- **Charles' Law:** "At constant pressure, the volume of a given mass of gas increases or decreases by 1/273 of its original volume at 32˚F, for each degree centigrade rise or lowering in temperature."
- **Pressure Law:** Volume remaining constant, the pressure of a given mass of gas increases or decreases by a constant fraction (=1/273) of its pressure at 0˚C for each degree Celsius rise or fall of temperature.
- **Avogadro's Law:** This is quite intuitive: the volume of a gas confined by a fixed pressure varies directly with the quantity of gas. Equal volumes of gases, measured at the same temperature and pressure, contain equal numbers of molecules. Avogadro's law thus predicts a directly proportional relation between the number of moles of a gas and its volume.
- **Gay-Lussac's Law:** When different gases react with each other chemically to produce gaseous substances, then under the same condition of temperature and pressure, the volume of the reacting gases and product gases bear a simple ration among one another.
- **Avogadro Number:** From Avogadro's hypothesis, we know equal volume of all gases contain equal number of molecules at normal temperature and pressure.
  The number is known as Avogadro Number and is equal to6.06X1023.
- **The ideal gas equation of state:** If the variables P, V, T and n (the number of moles) have known values, then a gas is said to be in a definite state, meaning that all other physical properties of the gas are also defined. The relation between these state variables is known as an equation of state.
- An ideal gas is an imaginary gas that follows the gas laws and has 0 volume at 0 K i.e., the gas does not exist.

STRUCTURE OF ATOM

The atomic theory of matter was first proposed by John Dalton.Fundamental particles of an atom are Electron, Proton and Neutron.

1. **Proton (p):** Discovered by Rutherford.
- Protons are positively charged.
- The absolute charge on the electron to be + 1.6 × 10–19 C.

2. Electron (e): Discovered by J.J. Thomson when he was studying the properties of cathode ray.

- Irish physicist George Johnstone Stoney **named** this charge '**electron**' in 1891.
- Electrons are negatively charged.
- The absolute charge on the electron to be – 1.6 × 10–19 C.
- e/m_e as: = 1.758820 × 1011 C kg–1
- The charge of an electron was measured by R. Millikan in Oil drop experiment.

3. Neutrons (n) - J. Chadwick

- It has no charge and a mass nearly equal to that of a proton.
- The mass of a neutron is taken as one unit each.

4. Atomic nucleus – Rutherford

- The fast moving alpha (α)-particles (doubly-charged helium ions) were made to fall on a thin gold foil.
- The mass of an atom is the sum of the masses of protons and neutrons present in the nucleus.

5. Valency

- The number of electrons gained, lost or shared so as to make the octet of electrons in the outermost shell, is called valency.
- The atoms of elements, having a completely filled outermost shell show little chemical activity,their valency is zero.
- An outermost-shell, which had eight electrons is said to possess an octet. Atoms would thus react, so as to achieve an octet in the outermost shell.
- The chemical behavior of an atom depends upon the number of electrons orbiting around the nucleus.

6. Atomic Number

The atomic number is defined as the total number of protons present in the nucleus of an atom. It is denoted by "Z".

7. Mass number

The mass number is defined as the sum of the total number of nucleons (protons and neutrons) present in the nucleus of an atom.

8. **Mole and Avagadro number** – According to new definition of Mole given by IUPAC "One mole contains exactly 6.03×10^{23} elemetary entities. Thus, avagadro number or avagadro constant, is the no. of particles found in one mole of a substance i.e. 6.023×10^{23} particles per mole.

9. Isotopes

- Atoms which have the same atomic number but different mass numbers.The chemical properties of isotopes are similar but their physical properties are different.But some isotopes have special properties which find them useful in various fields. Some of them are :
- (i) An isotope of uranium is used as a fuel in nuclear reactors.
- (ii) An isotope of cobalt is used in the treatment of cancer.
- (iii) An isotope of iodine is used in the treatment of goiter

<u>Radioactive isotopes</u>

Arsenic–74 → detect tumors
Sodiun–24 → Blood clot
Iodine–131 → Activity of thyroid gland
Cobalt–60 → Treat of cancer

10. ISOBARS- Atoms of different elements with different atomic numbers, which have the same mass number, are known as isobars.

11. Isotones – atoms having same number of neutrons.

12. Isoelectronics – atoms/molecules/ions containing sae number of electrons.

13. Mass defect - The mass defect is the difference between the rest mass of a nucleus and the sum of the rest masses of its constituent nucleons.

14. Binding Energy

- The binding energy of a nucleus is the energy required to separate a nucleus into its constituent parts.
- For heavier nuclei, energy is released when they break up (fission).
- For lighter nuclei, energy is released when they fuse together (fusion).
- Nuclear particles are held together by a nuclear strong force.A stable nucleus remains forever, but as the ratio of N/Z gets larger, the atoms decay. Elements with Z > 82 are all unstable.
- As the heavier atoms become more unstable, particles and photons are emitted from the nucleus and it is said to be radioactive. All elements with A > 82 are radioactive.

Examples are:

Alpha particles - (2 proton and 2 neutron) least penetrating
beta-minus particles - (electron) penetrating
beta- plus particles - (positron) penetrating
Gamma rays - most penetrating, high electromagnetic radiation.

Half-Life period - The half half-life of an isotope is the time in which one one- half of its unstable nuclei will decay.
$N = N_0(1/2)^n$, Where n is number of half-lives

ACID, BASE AND SALTS

1. Acid

- An acid is a compound, produce hydrogen ions, H+(aq), in solution, which are responsible for their acidic properties.
- According to Bronsted-Lowry theory, an acid is any species that can donate a proton to another species.
- Hydrogen ions cannot exist alone, but they exist after combining with water molecules.so, on dissolving in water yields hydronium ions (H_3O+) as the only positive ions.
- The presence of hydrogen ions makes acids strong and good electrolytes.

Strong Acid:

- Examples of strong acids are: hydrochloric acid, sulphuric acid, nitric acid etc.

Weak Acid:

Examples are: acetic acid, formic acid, carbonic acid etc.

- Acids are generally sour in taste and corrosive.

- Indicators: Test whether a substance is acidic or basic.
  Eg: Turmeric, litmus, China rose petals (Gudhal), etc., are some of the naturally occurring indicators.
- Litmus is extracted from lichens a plant belonging to the division Thallophyta. It has a purple colour in distilled water. When added to an acidic solution, it turns red and when added to a basic solution, it turns blue.
- The solutions which do not change the colour of either red or blue litmus are known as neutral solutions. These substances are neither acidic nor basic.
- Olfactory indicators: There are some substances whose odour changes in acidic or basic media.

Uses of Acids

- (i) Hydrochloric acid present in our stomach helps in the digestion of food.
- (ii) Vitamin C or ascorbic acid gives the needed nutrients for body.
- (iii) Carbonic acid is used in making carbonated beverages and fertilizers.
- (iv) Vinegar a preservative is a dilute form of acetic acid.
- (v) Sulphuric acid is used in the manufacture of fertilizers, paints, synthetic fibres etc.
- (vi) Nitric acid is used in the preparation of aqua regia, used in the purification of precious metals like gold and silver.
- (vii) Boric acid is used to wash eyes.
- (viii) Phosphoric acid is used in making fertilizers and detergents.
- **Basicity of an acid** is defined as the no of ionizable hydrogen (H+) ions present in one molecule of an **acid**

Acids	Formulae	Basicity
Hydrochloric acid	HCL	1-Monobasic
Nitric acid	HNO_3	1-Monobasic
Carbonic acid	H_2CO_3	2-Dibasic
Sulphuric acid	H_2SO_4	2-Dibasic
Phosphorous acid	H_3PO_3	2-Dibasic
Phosphoric acid	H_3PO_4	3-Tribasic

For the acid containing the carboxylic acid, we do not count the number of hydrogen atoms but the number of carboxyl group (i.e.) -COOH

ACIDS USED IN DAY-TO-DAY LIFE

Acids are obtained from two different sources. They can be organic or mineral acids. All acids have some common characteristic properties.

Sources of the acid	Name of the acid
Vinegar	acetic acid
Citrus fruits	citric acid
Grapes, tamarind, gooseberries.	tartaric acid
Sour milk	lactic acid
Apples	malic acid
Curd	butyric acid
Tea, tomatoes	oxalic acid
Sting of red ants and bees	formic acid
Proteins	amino acids
Guava, oranges	ascorbic acid

Note: The process of dissolving an acid or a base in water is a highly exothermic one. The acid must always be added slowly to water with constant stirring.

2. Bases and Alkalis

- A Base is a substance that gives OH-ions when dissolved in water. Bases are usually metal hydroxides (MOH).
- According to Bronsted-Lowry theory, a base is a proton acceptor.
- Bases are soapy substances with a bitter taste .
- The strength of a base depends on the concentration of the hydroxyl ions when it is dissolved in water.
- Bases soluble in water are called alkalies. All alkalies are bases but all bases are not alkalies.

Strong Base:
Examples:
Sodium hydroxide: NaOH (caustic soda),, Potassium hydroxide: KOH(caustic potash), Calcium hydroxide: $Ca(OH)_2$.

Weak Base:
Examples: Magnesium hydroxide: $Mg(OH)_2$, Ammonium hydroxide: NH_4OH.

SALT
Potash alum (potassium aluminum sulfate $KAl(SO_4)_2$**)**
(i) It is used in dyeing industries to fix the dye to the fabric.
(ii) It is used for cleaning teeth.

USES OF SALTS IN INDUSTRIES:
(i) Sodium chloride is used in the manufacture of chlorine, caustic soda, washing soda and baking soda.
(ii) Ammonium salts are used as fertilizers.
(iii) Potassium nitrate is used in the manufacture of gun powder and fire works.
(iv) Silver bromide is used in photography.
(v) Potassium chlorate is used in the match industry.
(vi) Aluminium sulphate is used in preparing alums.

3. pH SCALE

The p in pH stands for 'potenz' in German, meaning power.

- The scale that measures the strength of an acid or a base is called the pH scale. This value lies between 0 and 14.
- Higher the hydronium ion concentration, lower is the pH value.
- The pH of a neutral solution is 7. Values less than 7 on the pH scale represent an acidic solution. As the pH value increases from 7 to 14, it represents an increase in OH– ion concentration in the solution, that is, increase in the strength of alkali.
- Most food crops grow best at a PH of 7-7.8.If the soil is too acidic then its pH can be raised by adding lime (or slaked lime) which neutralizes the excess acid in the soil.Similarly, if the soil is too alkaline then its pH can be lowered by adding gypsum or some other substance which can neutralize the excess alkali present in the soil.
- The medium in our stomach is highly acidic and has pH around 1.2. Our stomach produces hydrochloric acid which helps in digestion of food. Magnesium hydroxide (Milk of magnesia), a mild base, is an antacid which neutralises the excess acid.
- Tooth decay starts when the pH of the mouth is lower than 5.5.
- Acid Rain- When pH of rain water is less than 5.6, it is called acid rain.
- Gastric juice - 1.2
- Lemon Juice - 2.2
- Pure water - 7.4
- Milk of mgnesia - 10
- Sodium hydroxide solution - 14
- Note - The atmosphere of Venus is made up of thick white and yellowish clouds of sulphuric acid.

CLASSIFICATION OF ELEMENTS

Mendeleef's Periodic Table (1869)

States that, "the physical and chemical properties of elements are the periodic function of their atomic masses."

Modern Periodic Law

"The physical and chemical properties of the elements are periodic function of their atomic numbers."

Long Form of Periodic Table

Long form of periodic table or Bohr's table is based on **Bohr-Burry concept** of electronic configuration. It contains 7 periods (horizontal rows) and 18 groups.

Periodic Properties

The properties which are repeated at regular intervals are known as periodic properties, i.e. periodic properties show a regular order along a group and period. Some important periodic properties are

Ionisation enthalpy

It is the minimum energy required to remove an electron from an isolated gaseous atom of an element to form a positive ion.

Electron gain enthalpy

It is the energy released by an element when an extra electron is added to its neutral gaseous atom.

Electronegativity

It is the ability of an atom to attract the shared pair of electrons towards it.

Metallic character

It is the tendency of an element to form cation by the loss of electrons.

CHEMICAL REACTIONS AND EQUATION

Physical Change

- The changes that only affect physical properties, but the chemical compositions remains unchanged, are called **physical change**.
- These can be reversed by changing the conditions of temperature and pressure, boiling, cutting of trees, dissolving common salt in water burning of wax.

Chemical Change

- The change which affects the composition as well as chemical properties of matter and result in the formation of a new substance is called a chemical change.
- Chemical changes are generally irreversible. Some examples of chemical changes are burning of candle (gases), photosynthesis, ripening of fruits, electrolysis of water.
- A chemical reaction involves bond breaking or bond formation between any two atoms to produce new substances.

Types of Chemical Reactions:

Exothermic and Endothermic Reactions

Reactions, in which heat is released along with the formation of products, are called **exothermic reactions**. Burning of fuel is an example of exothermic reaction.
Reactions, in which heat is absorbed, are known as **endothermic reactions.**

Oxidation and Reduction

- Oxidation is removal of electrons.
- Reduction is the addition of electrons.
- Oxidation means
  (a) addition of oxygen
  (b) Removal of hydrogen.
- Reductions means
  (a) Removal of oxygen.
  (b) Addition of hydrogen.
- The substance that causes oxidation is called the oxidizing agent.
- The substance that causes reduction is called the reducing agent.

Oxidising agent
1. Acceptors of electrons.
2. It is a substance which removes the electron from an atom.
3. It brings about oxidation.

Reducing agent
1. Donors of electrons.
2. It is a substance which adds electrons to an atom.
3. It brings about reduction.

REDOX REACTION
A reaction which involves oxidation and reduction occurring simultaneously together are called redox reaction. Photosynthesis in plants digestion of food in animals; dry and wet batteries and corrosion of metals are diverse examples of oxidation and reduction reactions.

Electrolysis
- Electrolysis is carried out in an electrolytic cell.
- A simple electrolytic cell consists of two copper strips dipping in an aqueous solution of copper sulphate.
- On applying DC voltage to the two electrodes, copper metal is deposited on cathode and copper is dissolved at anode.
- Used In the purification of impure metals.
- In the extraction of metals
- The blocks used in typing industries are prepared by electrolysis.
- Steel is coated with zinc metal during the process of galvanization.

Batteries
These convert chemical energy into electrical energy. Mainly two types of batteries are used, i.e. primary and secondary.

Primary Batteries
In the primary batteries, reaction occurs only once and after a period of time battery becomes dead.

Dry Cell or Leclanche Cell
It consists of a zinc container that acts as anode and the cathode is a carbon (graphite) rod surrounded by powdered manganese dioxide and carbon.
A moist paste of ammonium chloride (NH_4CI) and zinc chloride $(ZnCI_2)$ is used as an electrolyte. Dry cell is commonly used in our transistors and clocks.

Mercury Cell
It is commonly used in low current devices such as hearing aids, watches etc.
The electrolyte is a past of potassium hydroxide (KOH) and zinc oxide (ZnO).

Secondary Batteries

Lead Storage Battery
It consists of a lead as anode and a grid of lead packed with lead dioxide (PbO_2) as cathode.
A 38% solution of sulphuric acid is used as an electrolyte. On charging the battery, the reaction is reversed and lead sulphate gives lead on anode and cathode is converted into lead dioxide respectively.

Nickel Cadmium Cell
It has longer life that the lead storage cell. It consists of a cadmium as anode and nickel dioxide as cathode. The electrolyte is a potassium hydroxide (KOH) solution.

Fuel Cells
Fuel cells convert energy from the combustion of fuels such as hydrogen, carbon monoxide, methane directly into electrical energy
A fuel cell with hydrogen and oxygen has been used for electric power in Apollo Space Programme.

Corrosion
- When iron is exposed to moist air for a long period of time, its surface acquires a coating of brown flaky substance called **rust**.
- Rust is mainly hydrated iron (III) oxide $(Fe_2O_3.xH_2O)$.
- In corrosion, a metal is oxidized by the loss of electrons to oxygen and form oxide.
- The rusting of iron can be prevented by painting, oiling and greasing, galvanizing (by coating iron objects with zinc), chrome plating etc.

Catalysis
- A catalyst is a substance which alters the rate of reaction.
- The catalyst itself does not alter during the reaction.
- The phenomenon in which the rate of reaction is altered by the presence of a substance (**catalyst**) is known as catalysis.
- Catalysts are specific in their action.
- A catalyst does not change the equilibrium state of a reversible reaction, only brings it quickly.
- The main function of a catalyst in a reaction is to decrease the activation energy.

Applications of Catalysts in Industrial Processes
- Haber process for ammonia—Iron is used as a catalyst and molybdenum is used as a promoter of catalyst iron.
- Contact process for sulphuric acid—Vanadium pentoxide is used as a catalyst.
- Ostwald process for nitric acid—Platinum gauze is used as a catalyst.
- Deacon process for chlorine—cupric chloride is used as a catalyst.
- Synthesis of petrol—Nickel, iron, cobalt and alumina is used as a catalyst.

Enzyme Catalysis

The increase in the rate of reaction by the enzymes is known as enzyme catalysis. They are biocatalysts, all are proteins in nature.

The rates of enzymatic reactions are very much affected by pH change.

Some important enzyme catalysis reactions are as follows

- Starch $\xrightarrow[H_2O]{\text{Diastase}}$ Maltose
- Maltose $\xrightarrow[H_2O]{\text{Maltase}}$ Glucose
- Glucose $\xrightarrow{\text{Zymase}}$ Ethyl alcohol
- Sucrose $\xrightarrow{\text{Invertase}}$ Glucose + Fructose
- Urea $\xrightarrow[H_2O]{\text{Urease}}$ Ammonia + Carbon dioxide

CHEMICAL BONDING

Chemical Bonding

Constituents (atoms, molecules or ions) of different elements except noble gases, do not have complete octet so they combine with other constituent atoms by chemical bonds to achieve complete (stable) octet. The process of their combination is called chemical bonding. Chemical bonding depends upon the valency of atoms.

Types of Chemical Bond

They are divided in the following types depending upon the mode electron transferred or shared electrons or forces of attraction

- Electrovalent or ionic bond - Covalent bond
- Coordinate or dative covalent bond - Hydrogen bond
- van der Waals' forces

Electrovalent Bond

The bond formed by the transfer of electrons from one atom to another is called electrovalent bond and the compound is called **electrovalent compound** or **ionic compound**. These bonds are formed between metals and non-metals.

These conduct electricity when dissolved in water and also soluble in water. These are insoluble in organic solvents like alcohol etc.

Some Electrovalent Compounds (Ionic Compounds)

Name	Formula	Ions present
Aluminium oxide (Alumina)	AI_2O_3	AI^{3+} and O^{2-}
Ammonium chloride	NH_4CI	NH_4^+ and CI^-
Calcium chloride	$CaCI_2$	Ca^{2+} and CI^-

Covalent Bond

The bond is formed by the sharing of electrons between two atoms of same (or different) elements, is called covalent bond.

Covalent bond may be single, double or triple depends upon the number of sharing pairs of electrons.

Covalent compounds are usually liquids or gases having low melting point and boiling point. These do not conduct electricity and are insoluble in water but dissolve in organic solvent.

Some Covalent Compounds

Name	Formula	Element's part
Alcohol (Ethanol)	C_2H_5OH	C, H and O
Ammonia	NH_3	N and H
Acetylene (Ethyne)	C_2H_2	C and H

Coordinate or Dative Bond

The bond is formed by one sided sharing of one pair of electrons between two atoms. The necessary condition for the formation of coordinate bond is that octet of one atom should be complete; having atleast one lone pair of electrons and other atom should have a deficiency of atleast one pair of electrons.

The atom having complete octet which provides the electron pair for sharing, is known as **donor**. The other atom which accepts the electron pair is called the **acceptor**.

Bonding between A and B is predominantly

– Ionic if there is large difference in electronegativity.

– Covalent if both A and B have approximately same value of electronegativity.

– Coordinate if lone pair on A (or B) is donated to electron deficient B (or A).

Compounds Containing Ionic and Covalent Bonds

Name	Formula
Potassium cyanide	KCN
Sodium hydroxide	NaOH
Calcium carbonate	$CaCO_3$

Compounds Containing Covalent and Coordinate Bonds

Name	Formula
Carbon monoxide	CO
Ozone	O_3
Dinitrogen oxide	N_2O
Dinitrogen trioxide	N_2O_3
Nitric acid	HNO_3

Compounds Containing Electrovalent, Covalent and Coordinate Bonds

Name	Formula
Ammonium chloride	NH_4CI
Ammonium bromide	NH_4Br

Hydrogen Bond

The electrostatic force of attraction between hydrogen atom (which is covalently bonded to a highly electronegative atom) and any other electronegative atom which is present in the same or different molecules, is known as hydrogen bond.

It is maximum in the solid state and minimum in the gaseous state.

- **Intermolecular H-bonding** (e.g. HF, water (H_2O) molecule) It occurs between different molecules of a compound and results in increasing solubility in water and high boiling point.
- **Intramolecular H-bonding** (e.g. o -nitrophenol) It occurs within different parts of a same molecule and results in decreasing solubility in water and low boiling point.
- Molecules having O—H, N—H or H—F bond show abnormal properties due to H-bond formation. For example
- Glycerol is viscous and has very high boiling point due to the presence of intermolecular H-bonding.
- H-bonding also plays an important role in biological system and stability of proteins and nucleic acids.

Van der Waals' Forces

The ability of geckos (lizard) which can hang on a glass surface using only one toe to climb on sheer surfaces had been attributed to the van der Waals' forces between these surfaces and their foot-pads.

Metals & Nonmetals

- Metals are generally **good conductors of heat and electricity**.
- Silver is the best conductor of heat followed by copper.
- Mercury offers a very high resistance to the passage of electric current.
- Metals are generally **hard** but sodium and potassium are so **soft** that they can be easily cut with a knife.
- Metals are malleable and ductile. Gold and silver are most malleable and best ductile metals.
- Metals are solids at room temperature except mercury (mp – 39°C) which is liquid, caesium (mp 28.4°C) and gallium (mp 29.8°C) are liquid above 30°C.
- Metals are electropositive in nature, they ionize by the loss of electrons and form positive ions.
- Almost all the metal oxides are basic in nature but zinc oxide and aluminium oxide are amphoteric.
- Lithium, sodium, potassium, rubidium and caesium are alkali metals. Alkali metals are stored under kerosene or liquid paraffins to protect them from action of air.
- Metallic sodium is prepared by the electrolysis of molten mixture of 40% sodium chloride and 60% calcium chloride in a **Down's cell**.
- **Sodium bicarbonate**($NaHCO_3$), baking soda is used in effervescent drinks and fruit salts in fire extinguishers and it is also used in the form of sesquicarbonate. It is used for wool washing.
- **Sodium carbonate** ($Na_2CO_3.10H_2O$) washing soda is used in the manufacturing of glass, soap, washing powder and for softening hard water.
- Mixture of sodium carbonate and potassium carbonate is known as **fusion mixture**.
- **Sodium sulphate** ($Na_2SO_4.10H_2O$) is Glauber's salt. It is used as purgative.
- **Sodium thiosulphate** ($Na_2S_2O_3.5H_2O$) or **Hypo** It is used in the photography as a fixing agent.
- **Potassium superoxide** (KO_2) used in space capsules, submarines and breathing masks as it produces oxygen and removes carbon dioxide and carbon monoxide.
- **Potassium** cyanide (KCN) is used in the extraction of silver, gold and as a germicide in agriculture. KCN is more poisonous than sodium cyanide.
- Potassium hydroxide (KOH) is known as caustic potash used in the preparation of soft soap. Its aqueous solution is known as **potash lye.**
- **Potassium carbonate** (K_2CO_3) is potash or pearl ash.

De-icing of Roads after snowfall

De-icing in the process of removing ice from a surface by using salts on the surface. Now-a-days, liquid $CaCI_2$ and $MgCI_2$ are also used for this purpose.

Alkaline Earth Metals and their Compounds

Beryllium, magnesium, calcium, strontium, barium and radium are collectively known as alkaline earth metals. Be $(OH)_2$ is amphoteric in nature. Mg $(OH)_2$ is called **milk of magnesia** and used as an **antacid.**

Calcium oxide (CaO) is also called **quick lime**. It is used in the manufacturing of glass, calcium chloride, cement, bleaching power, calcium carbide, slaked lime, in the extraction of iron and as a drying agent for ammonia and alcohol.

Calcium hydroxide, slaked lime $[Ca(OH_2)]$ is used in the manufacturing of caustic soda, sodalime and for softening of hard water.

Calcium sulphate, gypsum $(CaSO_4.2H_2O)$ loses a part of its water of crystallization when heated upto 120°C to from $[CaSO_4]_2.H_2O$ which is known as **plaster of Paris**.

Plaster of Paris is a white powder, which sets into hard mass on wetting with water and it is used in making statues, toys, etc., in medical applications of setting fractured bones in right positions and indentistry.

Some Important Metals and their Uses

Boron (B)

It is a semimetal (metalloids). In the nature, it occurs in combined state as borax.

Boron and boron carbide rods are used to control the nuclear reactions.

Boron carbide (B_4C) is hardest, known as an artificial substance after diamond and is known as **Norbia.**

Orthoboric acid (H_3BO_3) is used as an antiseptic and eye wash under the name boric lotion.

Aluminium (Al)

It is a third most abundant element of Earth's crust. It is extracted from bauxite $(AI_2O_3.2H_2O)$. Aluminium powder is used in fireworks, flash light powder, thermite welding.

Ammonal (a mixture of aluminium powder and ammonium nitrate) is used as an explosive.

Ruby and sapphire are essentially AI_2O_3. Ruby is red due to the presence of Cr and sapphire is blue due to Fe and Ti. Emerald is green, it contains Ca/Cr and aluminium silicates (AI_2SiO_3).

Tin (Sn)

The important ore of tin is cassiterite (SnO_2) or tin stone. In cold countries, white tin is converted to grey tin (powder), the process is known as **tin disease** or **tin plague.** Tin plating is done to prevent the rusting of iron. Tin amalgam is used in making mirrors. Pentahydrate of stannic chloride $(SnCI_4.5H_2O)$, is called butter of tin used as mordant in dyeing.

Lead (Pb)

Lead is mainly found in the form of sulphide ore called **galena** (PbS). Red lead (minium or sindhur) is Pb_3O_4 used for making protective paint for iron and in match industry.

Zirconium (Zr)

It is used for making core of nuclear reactors and for making pumps, valves and heat exchangers.

Vanadium (V)

Vanadium pentoxide (V_2O_5) is a very good catalyst for manufacturing of sulphuric acid by contact process.

Tungsten

Tungsten filaments are used in electric bulbs. Calcium tungstate is used in X-ray tube.

Iron (Fe)

It is extracted from its haematite ore.

Cast iron It is the most impure form of iron and contains 2.5–4% carbon.

Wrought iron or **Malleable iron** is the most purest form of iron and contains minimum amount of carbon (0.12–0.5%)

Iron (II) is present in haemoglobin (blood).

Mild steel contain 0.25%–0.5% carbon while hard steels contains 0.5%–1.5% carbon. Soft steels contain carbon upto 0.25%.

Stainless steel is an alloy of iron (Fe), chromium (Cr) and nickel (Ni). Ferric chloride $(FeCI_3)$ is used as stypic to stop bleeding from a cut. Ferrous sulphate $(FeSO_4)$ is used in making blue black ink.

Copper, Silver and Gold (Cu, Ag and Au)

These are called coinage metals. Silver is used as amalgam for filling teeth and in silvering mirrors. Silver bromide (AgBr) is used in photography. $AgNO_3$ is called **lunar caustic** used in preparing marking inks and hair dyes.

$CuSO_4.5H_2O$ is called **blue vitriol** or **nila thotha** and $CuFeS_2$ is called fool's gold.

Mercury (Hg)

Mercuric sulphide (HgS) is used as a cosmetic in Ayurvedic medicine as Makardhwaja.

Zinc (Zn)

It is used in galvanization to prevent rusting of iron. Zinc sulphide is used in the preparation of X-ray screens.

Zinc oxide is known as **philosopher's wool**. Zinc sulphate $(ZnSO_4.7H_2O)$ is white vitriol.

Metallurgy

The process of extraction of metals from their ores is called metallurgy.

Minerals, Ores and Gangue

The natural substance in which metals and other impurities found in combined state, are called minerals.

The minerals from which metal can be extracted conveniently and beneficially, are called ores. **Gangue or matrix** are the impurities associated with the ore.

Metal	Ores	Chemical composition
Sodium	Rock salt Chile salt petre Borax	NaCl $NaNO_3$ $Na_2B_4O_7.10H_2O$
Potassium	Carnallita Sylvine	$KCI.MgCI_2.6H_2O$ KCl
Magnesium	Carnallite Magnesite Asbestos	KCl.$MgCI_2.6H_2O$ $MgCO_3$ $CaSiO_3.3MgSiO_3$
Calcium	Lima stone Gypsum Fluorspar	$CaCO_3$ $CaSO_4.2H_2O$ CaF_2
Aluminium	Bauxite Cryolite Feldspar	$AI_2O_3.2H_2O$ Na_3AIF_6 $KAISi_3O_8$
Manganese	Pyrolusite Manganite Manganese blende	MnO_2 $Mn_2O_3.H_2O$ MnS
Iron	Haematite Magnetite Iron pyrites Siderite	Fe_2O_3 Fe_3O_4 FeS_2 $FeCO_3$
Copper	Copper glance Copper pyrites Malachite Azurite	Cu_2S $CuFeS_2$ $Cu(OH)_2.CuCO_3$ $2CuCO_3.Cu(OH)_2$
Silver	Silver glance Horn silver	Ag_2S AgCl
	Ruby Silver	$Ag_2S.Sb_2S_3$
Gold	Calverite Sylvanite	$AuTe_2$ $AuAgTe_4$
Zinc	Zinc blende Calamine Zincite Franklinite	ZnS $ZnCO_3$ ZnO ZnO.Fe_2O_3
Mercury	Cinnabar	HgS
Tin	Cassiterite	SnO_2
Lead	Galena Cerrusite Anglesite	PbS $PbCO_3$ $PbSO_4$

Some Important Alloys and their Uses

Non-Metals

These may be solid, liquid or gas (bromine is the only liquid non-metal).

These are soft, non-lustrous, brittle, non-sonorous and non-conductor of heat and electricity. These have low melting and boiling points. These from oxides with oxygen which are generally acidic. Their examples include noble gases, i.e. helium (He), neon (Ne), argon (Ar), krpton (Kr), xenon (Xe) and some other p-block elements like chlorine (CI_2), bromine (Br_2) and phosphorus (P) etc.

Alloys are homogeneous mixtures of metals and cannot be separated into their components by physical methods. Pure metals have poor mechanical properties. Hence, they are not used in their pure form in industry. Their properties are modified by adding other elements.

Characteristics of alloys:

Alloys are harder and tougher than the base metal and are resistant to corrosion.

They are inert to commonly used chemicals and are magnetisable and ductile.

Alloy is considered as a mixture because it shows the properties of its constituents and can have variable composition.

Amalgams:

Alloys of mercury with other metals like sodium, potassium,gold and zinc...etc are called amalgams.

Amalgams stored in iron bottles as iron cannot form amalgam with mercury.

Rold Gold is a metal, such as brass, coated with a thin layer of gold, usually of above 9 carat purity.

Brass

Composition- zinc 30%, copper 70%

uses- In making of utensils, pipes and radiator statues etc.

Yellow Brass

composition - Cu 67%, Zn 33%

uses - Hardware items

Bronze

Composition - Copper 90%, Tin 10%

uses - In making of coins, ornaments, utensils and statues.

Stainless steel

composition - Fe 82%,(Ni + Cr) 18

uses - In making of surgical instruments, watches and utensils etc.

Magnalium

composition- Al 95% ,Mg 5%

uses - In making light articles and physical balance etc.

Duralumin

composition- Al 95%, Cu 4% ,Mn 0.5%

uses -In making parts of aeroplane and ship etc.

Alnico
composition - Al 8-12% , Ni 15-26% , Co 5-24% ,Cu 6%
Remaining: Fe, Tl
uses - It is useful in making of magnets.

German silver
composition - Cu 60% ,Zn 20%, Ni 20%
uses - It is useful in electroplating and making of utensils.

sterling Silver
composition - silver 92.5%, copper 7.5%
uses - jewelry, art object

Gun metal
composition - Cu 88%, Sn 10%,Zn 2%
uses - It is useful in making of guns, machine parts and canons.etc

Solder metal
composition - Pb 50%, Sn 50%
uses - It is mainly useful to join electric wires.

Bell Metal-
composition - copper - 77%, tin - 23%
uses- casting of bells

coin metal -
composition - copper 75%, nickel 25%
uses - U.S coins

wood's metal
composition - Bi 50%, Pb 25%, Sn 12.5%, Cd 12.5%
uses - fuse plugs, automatic sprinklers.

Monel
composition - Ni 67%,and copper, with small amounts of iron, manganese, carbon, and silicon.
uses - It is resistant to corrosion and acids and thus used for making valves, pumps, shafts, fittings, fasteners, and heat exchangers.
Plumber's solder
composition - Pb 67%, sn 33%
uses- soldering joints.

SOME COMMON ELEMENTS & COMPOUNDS

1. Carbon:

The three states of carbon are diamond, amorphous, and graphite.

- Carbon exhibits allotropy and shows maximum catenation.
- Carbon occurs both in Free State as diamond, coal etc. and also in the combined form as CO_2.
- Diamond is one of the allotropic forms of carbon and is the purest form of natural carbon. It is the hardest natural substance.
- Graphite is also an allotropic form of carbon, which is very soft and slippery. Graphite is prepared artificially by Acheson process.
- Fullerene (C_{60}) looks like a soccer ball. It contains 20 six membered and 12 five membered rings of carbon atoms.
- Graphene is an allotrope of carbon. It is a strong substance and used as a conducting material for touch screen, LCD and LED

2. Compounds of Carbon

Carbon monoxide (CO)

- Carbon monoxide (CO) combines with haemoglobin to form carboxyhaemoglobin which is not able to absorb oxygen and as a result of this, suffocation takes place (Asphyxia).
- The death of persons in closed rooms with wood, coal or coke fires and in closed bathrooms with gas geyser is due to the formation of carbon monoxide.

Carbon dioxide (CO_2)

- 0.03-0.05 percent in atmosphere.
- Solid CO_2 is known as dry ice. It is used in refrigerators under the name drikold. It is used in transport of perishable food materials as it provides cold as well as the inert atmosphere.

Carbides
They are the compounds of carbon with metals or electronegative elements.

- Destructive distillation of coal gives products like coal gas, gas carbon, coal tar and ammonical liquor.
- Lamp Black is also known as Soot.

3. Nitrogen:

- Nitrogen is a neutral gas and is neither combustible nor a supporter of combustion.

- In air (79% by volume). In combined state, nitrogen is found as nitrates (Chile salt petre—sodium nitrate ($NaNO_3$), Indian salt petre—potassium nitrate (KNO_3)

4. Compounds of Nitrogen
Ammonia
- It is prepared from nitrogen and hydrogen by Haber's process. It has pungent odour.
- Ammonia is used in manufacturing fertilizers and explosives etc.
- Nitrogen fixation involves the fixation of atmospheric nitrogen into nitrate by lightning and by nitrogen fixing bacteria called **Rhizobia.**

Oxygen:
- Oxygen is an important constituent of atmosphere (21% by volume). Supporter of combustion.
- **Liquid oxygen** mixed with freshly divided carbon, is used in place of dynamite in coal mining.
- **Ozone (O_3) -** It protects the life on the earth by not allowing UV rays to reach the Earth.The common refrigerants, chlorofluorocarbons deplete this ozone layer.
- Its bleaching action is due to its oxidizing action.
- Ozone is also used as a germicide and disinfectant, for sterilizing water.

Phosphorus (P):
- It is highly reactive non-metal, so it occurs only in combined state.
- Phosphorus is an essential constituent of bones, teeth, and blood and nerve tissues. Bone ash contains about 80% of phosphorus.

Sulphur (S):
- It occurs in Free State in volcanic region.
- Rhombic sulphur is the most stable form at ordinary temperature and all other forms gradually change into this form.

Compounds of Sulphur
- **Sulphuric acid** is also known as **oil of vitriol** or **king of chemicals.** It has a great affinity for water and thus it acts as a powerful dehydrating agent. Corrosive action of sulphuric is due to its dehydrating action.
- **Hypo** (Sodium thiosulphate) It is mainly used in photography as a fixing agent. It is used to remove undecomposed silver halide on photographic paper or film.

Halogens:
Halogens are highly reactive elements and therefore, they do not exist in Free State but exist only in combined form.
Halogens have highest electron affinity so they act as strong oxidizing agent.
Their oxidizing power decreases from fluorine to iodine.

Chlorine:
Chlorine was first discovered by Scheele (1774)
Chlorine is used as a germicide, disinfactant, oxidizing agent, bleaching agent in paper and textile industry.
Chlorine being an acidic gas turns moist blue litmus paper to red and then bleaches it.

Iodine (I_2)
Chile saltpeter or **caliche** contains iodine as sodium iodate (5-20%).
It turns starch solution blue. Solution of KI/I_2 is used in the treatment of goiter. It is used as an antiseptic as tincture of iodine.

Noble Gases
- Helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe) and radon (Rn) are known as inert gases or noble gases or rare gases.
- These elements have completely filled valence shell.
- It atmosphere, argon is most abundant noble gas but in universe, helium is most abundant gas.
- Natural gas in the most important source of helium.
- The mixture of helium and oxygen is used for artificial breathing of asthama patients.
- 85% helium + 15% hydrogen is used for filling in balloons and airships.
- Mixture of helium and oxygen is used for respiration by sea divers.
- Helium is used as pressuring agent in rockets to expel liquid oxygen and liquid hydrogen.
- Xe is also known as stranger gas and Xe-Kr is used in high intensity photographic flash tubes.
- Radon is used in the preparation of ointment for the treatment of cancer.

Water (H_2O):
- Water is called the "Universal Solvent".
- Hardness of water –
  Temporary hardness - Water is said to be temporarily hard when it contains bicarbonates of calcium and magnesium (or hydrogen carbonates). This type of hardness can be easily removed by boiling.
  Permanent hardness - Water is said to be permanently hard when it contains sulphates and chlorides of calcium and magensium.
  This hardness cannot be removed by boiling.
- **Degree of Hardness -** It is defined as the number of parts of $CaCO_3$ or equivalent to various calcium or magnesium salts present in 10^6 parts of water by mass.

- Heavy water is prepared either by prolonged electrolysis or by fractional distillation of ordinary water. Heavy water (D_2O) is colourless, tasteless and odourless liquid. Fission in uranium-235 is brought by slow speed neutron. Heavy water is used for this purpose in nuclear reactors as moderators.

Hydrochloric Acid (HCL):

- Hydrochloric acid is prepared by dissolving hydrogen chloride gas in water.

It reacts with metals to form their respective chlorides and liberates hydrogen.

Hydrochloric acid is used in the production of dyes, drugs, paints, photographic chemicals and in the preparation of aqua-regia. Aqua regia is a mixture of nitric acid and hydrochloric acid, optimally in a molar ratio of 1:3. Aqua regia is a yellow-orange fuming liquid because it can dissolve the noble metals gold and platinum

Nitric Acid (HNO_3):

It is manufactured by the Ostwald's Process by the reaction of ammonia and air in presence of platinum as catalyst.

- Nitric acid is colourless in pure form. Commercial nitric acid is yellowish due to the presence of dissolved nitrogen dioxide.
- Nitric acid is a strong monobasic acid. It ionizes in water readily.
- Nitric acid is a strong oxidizing agent. When it undergoes thermal decomposition, it yields nascent oxygen.

BAKING SODA

- Chemically Baking soda is sodium hydrogen carbonate, $NaHCO_3$.
- Baking soda is manufactured by Solvey's process

USES

1. Used for cooking of certain foods.
2. For making baking power (a mixture of sodium hydrogen carbonate and tartaric acid). On heating during baking, baking soda gives off carbon dioxide. It is this carbon dioxide which raises the dough. The sodium carbonate produced on heating the baking soda gives a bitter taste. Therefore, instead of using the baking soda alone, baking powder is used. The tartaric acid present in it neutralises the sodium carbonate to avoid its bitter taste.
3. In medicines Being a mild and non-corrosive base, baking soda is used in medicines to neutralise the excessive acid in the stomach and provide relief. Mixed with solid edible acids such as citric or tartaric acid, it is used in effervescent drinks to cure indigestion.
4. In soda acid fire extinguishers.

WASHING SODA

- Chemically, washing soda is sodium carbonate decahydrate, $Na_2CO_3.10H_2O$.
- Washing soda is manufacturing by Solvey's process.

USES

1. It is used in the manufacture of caustic soda, glass, soap powders, borex and in paper industry.
2. For removing permanent hardness of water.
3. As a cleansing agent for domestic purpose.

PLASTER OF PARIS

- Plaster of paris, also called POP.
- Chemically, it is $2CaSO_4.H_2O$ or $CaSO_4.1/2H_2O$ (calcium sulphate hemi hydrate)
- Gypsum, ($CaSO_4.H_2O$) is used as the raw material

USES

4. In making casts for manufacture of toys and statues.
5. In hospitals for making plaster casts to hold fractured bones in place while they set. It is also used for making casts in dentistry.
6. For making the surface of walls and ceiling smooth.
7. For making 'chalk' for writing on blackboard.
8. For making fire proof materials.

BLEACHING POWDER

- Bleaching is a process of removing colour from a cloth to make it whiter.
- Chemically, it is calcium oxychloride, $CaOCl_2$.
- It is manufactured by Hasen-Clever Method.

USES

1. For bleaching of cotton, linen and wood pulp.
2. In making wool unshrinkable.
3. Used as disinfactant and germicide for sterilization of water.
4. For the manufacture of chloroform.
5. Used as an oxidizing agent in chemical industry.

CHEMISTRY IN EVERYDAY LIFE

Synthetic Materials

The materials created by man using the natural materials, are known as synthetic materials.

Cement

- It was discovered by an English Mason, Joseph Aspdin in 1824. He called it Portland cement because he thought that it resembled the limestone found in Portland.
- **Approximate Composition of Portland cement**

Calcium oxide (CaO)	60-70%
Silica (SiO_2)	20-25%
Alumina (Al_2O_3)	5-10%

Ferric oxide (Fe_2O_3) 2-3%

- Raw materials are limestone (provides lime), clay (provides alumina and silica), gypsum (reduces the setting time of cement).
- When water is mixed with cement and left as such for sometime, it becomes a hard mass. This is known as setting of cement. It is an exothermic process; therefore cement structures have to be cooled upto 7 days by sprinkling water.
- Mortar is a mixture of cement, sand and water. It is used for plastering walls and binding bricks and stones.
- Concrete is a mixtures of cement, sand, gravel or small pieces of stone and water. It is used for the construction of floors.
- The structure having iron rods embedded in wet concrete, is known as **reinforced concrete**.

Glass ($Na_2O.CaO.6SiO_2$)

- It is a supercooled liquid of silicates.
- Raw materials used for the formation of glass are sodium carbonate, calcium carbonate and sand.
- Finely powdered mixture known as **batch** is mixed with cullet (broken glass pieces) and then fused in a tank furnace at 1673 K. After few hours, molten glass is obtained.
- Molten glass is cooled slowly and uniformly. The process of slow and uniform cooling is known as **Annealing**
- Different addition may produce different coloured glasses.

Substance used	Colour of glass
Cuprous oxide	Red
Cupric oxide	Peacock blue
Potassium dichromate	Green or Greenish yellow
Ferrous oxide	Green
Ferric oxide	Brown
Manganese dioxide	Light pink, in excess black
Cobalt oxide	Blue
Gold chloride	Ruby
Cadmium	Yellow
Carbon	Amber colour

Variety of glass and **Uses**

- **Soft glass** - It is a mixture of sodium or calcium silicates. It is used in making window glass, mirrors and common glass wares etc.
- **Hard glass** - It is a mixture of potassium and calcium silicates. It is more resistant to the action of acids for making hard glass apparatus.
- **Flint glass** - It is mainly a mixture of sodium, potassium and lead silicates. It is used in making bulbs and optical instruments.
- **Pyrex glass** (Borosilicate glass) - It is used in making pharmaceutical containers, lab apparatus and over ware.
- **Quartz glass** (Silica glass) - It is used in the preparation of chemical apparatus and optical instrument.
- **Crookes glass -** It is used for making lenses for spectacles.
- **Photochromatic glass -** On exposure to bright light, photochromatic glass darkens temporarily. So, it is very useful as a Sun shield.
- **Safety glass -** The three layers are joined together by the action of heat and pressure. It does not break easily under impact and is used in auto vehicle wind shield.
- **Optical glass -** It is used for making lenses for microscope, telescope and spectacles.
- **Glass fibres** - used as insulating material in oven, refrigerator etc.
- **Optical fibres -** are extensively used in telecommunication surgical operations etc. Optical fibres can transmit images round corners.
- **Lead crystal glass -** Lead glass has a high refractive index. So, it is used for making expensive glass ware.
- **Etching of glass -** Glass is attacked by hydrofluoric acid (HF), therefore it is used in the etching of glass.

CHEMICALS IN AGRICULTURE

Fertilizers

- Urea is the best fertilizer as it leaves only carbon dioxide after ammonia, has been assimilated by plants.

- It has 46.6% mitrogen and it does not alter the pH of the soil.
- Mixture of $Ca(CN)_2$ and C is known as **nitrolim**. Commercially, calcium nitrate is known as Norvegian salt petre.
- The mixture of nitrogenous, phosphatic and potash fertilizers in suitable amounts, is called **NPK fertilizers.**

Pesticides

Pesticides are the chemicals which are applied to crops, e.g. DDT and **Malathion**.

Difethialone

Vitamin K has been suggested and successfully used, as antidote for pets or humans accidentally or intentionally exposed to anticoagulant poisons.

Chemicals in medicines

Analgesics (Pain relievers)

These reduce pain. Aspirin and paracetamol are non-narcotic analgesics. Aspirin reduces fever, prevents platelet coagulation.

Narcotic analgesics are chiefly used for the relief of post operative pain, cardiac pain and pains of terminal cancer and in child birth.

Polymerization

- Polymers are defined as high molecular mass macromolecules, which consist of repeating structural units derived from the corresponding monomers.
- Polymers occur in nature also. Cotton, for example, is a polymer called cellulose. Cellulose is made up of a large number of glucose units.

On the basis of intermolecular forces Polymers are classified as:

1. Elastomers- rubber, buna-S, buna-N, neoprene etc.
2. Fibres – polyamides (nylon 6, 6), polyesters (Terylene), etc.
3. Thermoplastic polymers - Such plastic which gets deformed easily on heating and can be bent easily are known as thermoplastics. Polythene and PVC, Polythene, Polystyrene, Polyvinyls, etc.
4. Thermosetting Polymers - some plastics which when moulded once, can not be softened by heating. These are called thermosetting plastics.eg: bakelite, melamine etc.

Few important polymers are:

(a)Polythene

(i)Low density polythene-polymerisation of ethene under high pressure in the presence of traces of dioxygen or a peroxide initiator (catalyst).

(ii)High density Polythene - polymerisation of ethene in the presence of a catalyst such as triethylaluminium and titanium tetrachloride (Ziegler-Natta catalyst).

(b)Polytetrafluoroethene (Teflon)- Teflon is manufactured by heating tetrafluoroethene with a free radical or persulphate catalyst at high pressures.

(c)Polyacrylonitrile - polymer of acrylonitrile in presence of a peroxide catalyst.

Condensation Polymerisation

(a)Polyamides - possess amide linkages

(i) Nylon 6, 6 - prepared by the condensation polymerization of hexamethylenediamine with adipic acid under high pressure and at high temperature

ii) Nylon 6 - obtained by heating caprolactum with water at a high temperature.

(b)Polyesters - polycondensation products of dicarboxylic acids and diols. Polyester is another synthetic fibre. Fabric made from this fibre does not get wrinkled easily. It remains crisp and is easy to wash. So, it is quite suitable for making dress material.

Eg: Terylene is the best known example of polyesters. It is prepared by ethylene glycol and terephthalic acid.It can be drawn into very fine fibres that can be woven like any other yarn.

(c)Phenol - formaldehyde polymer (Bakelite and related polymers)

Prepared by the condensation reaction of phenol with formaldehyde in the presence of either an acid or a base catalyst.

The initial product could be a linear product – Novolac used in paints. Novolac on heating with formaldehyde undergoes cross linking to form an infusible solid mass called bakelite. It is used for making combs, phonograph records, electrical switches and handles of various utensils.

Eg. Melamine – Melamine formaldehyde polymer is formed by the condensation polymerisation of melamine and formaldehyde. Melamine is a versatile material. It resists fire and can tolerate heat better than other plastics. It is used for making floor tiles, kitchenware and fabrics which resist fire. It is used in the manufacture of unbreakable crockery.

Copolymerisation.

Natural rubber - Natural rubber may be considered as a linear polymer of isoprene (2-methyl-1, 3-butadiene) and is also called as cis - 1, 4 - polyisoprene.

Vulcanisation of rubber-This process consists of heating a mixture of raw rubber with sulphur and an appropriate additive at a temperature range between 373 K to 415 K so that rubber gets stiffened.

Synthetic Rubbers -
(i) Neoprene - by the free radical polymerisation of chloroprene.
Rayon - rayon or artificial silk. Although rayon is obtained from a natural source, wood pulp, yet it is a man-made fibre.
Nylon - Nylon is also used for making parachutes and ropes for rock climbing. A nylon thread is actually stronger than a steel wire.

ORGANIC CHEMISTRY

Organic chemistry is defined as the study of hydrocarbons and their derivatives. Most atoms are only capable of forming small molecules. However one or two can form larger molecules.
Urea was the first organic compound prepared in laboratory. It was prepared by Wohler (1828) from inorganic compound i.e. ammonium cyanate.
Acetic acid was the first organic compound synthesized from the elements by **Kolbe**.
Functional group is responsible for the chemical properties of the molecules ex. OH is alcoholic group

Isomers Compounds having the same molecular formula but different structures, e.g. C_2H_6O can have the structure, i.e. CH_3OCH_3 (dimethyl ether) and C_2H_5OH (ethanol).

Hydrocarbons
These are the compounds of only carbon and hydrogen.
Saturated hydrocarbons They contain only single bonds. These are also called **alkanes** or **paraffins** and have general formula C_nH_{2n+2}. Methane is the first member of this group.

Unsaturated hydrocarbons They have general formula C_nH_{2n} for alkene and C_nH_{2n-2} for alkynes. These have atleast one double (=) or triple (≡) bond and are called **alkenes** and **alkynes** respectively.
Aromatic hydrocarbons They have ring structure with alternate double bonds and (4n + 2) πe^- (Huckel's rule) e.g. benzene.

Important Hydrocarbons and their Uses
Methane (CH_4) It is also known as marsh gas or damp fire. Natural gas contains mainly 90% methane along with ethane, propane, butane etc. Rice agriculture is a big source of atmospheric methane.

- It is the cause of occurrence of the explosions in mines.
- It is used as a fuel gas in making carbon black.

Biogas
Produced during decay of biomass in the absence of oxygen. Methane (75%) is the main constituent of biogas).

Ethane (C_2H_6)
Natural gas contains approx. 10% ethane. Its hexachloro derivative C_2Cl_6 is used as an artificial camphor.
Butane (C_4H_{10})
It is the main constituent of LPG (liquefied petroleum gas).
Ethylene ($CH_2 = CH_2$)
In World war | (1914-18), it was used for the manufacturing of mustard gas (poisonous gas). It is used as an anesthetic for the preservation and artificial ripening of green fruits.
Acetylene (CH ≡ CH)

Benzene (C_6H_6)
It is the simplest aromatic hydrocarbon. It was discovered by Faraday in 1825. It is also used as a motor fuel under the name benzol.

Toluene ($C_6H_5CH_3$)
It is used as a commercial solvent in the manufacturing of explosive (TNT), drugs (chloramines-T) and dyestuffs. Used in the manufacturing of saccharin and printing inks. toluene is used as antifreeze.
Naphthalene ($C_{10}H_8$)
It is used for preventing moths in clothes, as an insecticide.

Halogen Derivatives of Hydrocarbons
Chloroform ($CHCl_3$)

- It was discovered by **Sir James Young Simpson**.
- It is stored in closed dark coloured bottles completely filled because it is oxidized by air in the presence of sunlight to an extremely poisonous gas phosgene ($COCl_2$).
- It reacts with conc. HNO_3 and form chloropicrin ($Cl_3C - NO_2$). Chloropicrin is an insecticide and also used as poisonous gas at the time of war.
- The major use of chloroform today is in the production of the Freon refrigerant, R-22.

Iodoform (CHI_3)
It is used as an antiseptic due to liberation of free iodine.

Carbon tetrachloride (CCl_4)
used as a fire extinguishers under the name pyrene.
Dichloro diphenyl trichloro ethane (DDT)
It was the first chlorinated organic insecticides and originally prepared in 1873.

Alcohols
Methyl alcohol (CH_3OH)

- It is also known as wood spirit or wood naphtha.
- Methyl alcohol is poisonous in nature and when taken internally it can cause blindness and even death.
- It is used for denaturing alcohol (methylated spirit is denatured ethyl alcohol).

Ethyl alcohol (C_2H_5OH)
It is simply known as alcohol, spirit of wine or grain alcohol.

Glycerol $(CH_2OH.CHOH.CH_2OH)$
- It is an important trihydric alcohol known as glycerine.
- It is sweet in taste and very hygroscopic in nature. It is used in the manufacturing of cosmetics and transparent soaps.

Phenol (C_6H_5OH)
It is a monohydric benzene derivative. It is commonly known as carbolic acid or benzenol.

Methyl isocyanate (CH_3NCO)
Leakage of this gas is responsible for Bhopal gas tragedy.

Coal
- It is believed that is was formed by (carbonization). Different varieties of coal are anthracite (90% carbon), bituminous (70% carbon), lignite (40% carbon) and peat (10-15% carbon).
- On heating at 1270-1675 K in the absence of air, coal decomposes and gives the following products.
- **Coke** is the solid residue left after the distillation.
- **Coal tar** It is a mixture of about 700 substances.
- Now-a-days bitumen, a petroleum product, is used in place of coal tar for metalling the roads.
- The most significant characteristics of Indian coal are its high ash content, entrained gasifires and low sulphur content.
- The process of separation of various constituents/ fractions of petroleum is known as **refining**.
- **Knocking -** In a petrol engine, vapours of petrol and air are first compressed to a small volume and then ignited by a spark. If the quality of petrol is not good, it leads to the pre-ignition of fuel in the cylinder. This gives rise to a metallic sound known as knocking. Tetraethyl lead (TEL) and Benzene – Toluene – Xylene (BTX) are common antiknock compounds.
- **Octane number -** The antiknocking property of petrol is measured in terms of octane number. Higher the octane number, better is the quality of fuel. Gasoline used in automobiles has an octane number 80 or higher while in aeroplane, it has an octane number 100 or over higher.

Fuels:
- **Producer gas** is a mixture of carbon monoxide and nitrogen. Water gas in mixture of carbon monoxide and hydrogen.
- **Coal gas** is a mixture of hydrogen, methane, carbon monoxide, ethane, acetylene, carbon dioxide, nitrogen and oxygen.
- **Oil gas** and petrol gas is a mixture of methane, ethylene and acetylene etc., and is obtained by cracking of kerosene.
- **LPG** (Liquefied Petroleum Gas) the mixtures of hydrocarbons such as propane, propene, n-butane, isobutene and various butane with small amount of ethane.The major sources of LPG are natural gas.
- **CNG** (Compressed Natural Gas) It is highly compressed from of natural gas, octane rating of CNG is 130.
- **Gasohol+** It is a mixture of ethyl alcohol (10%) and petrol (90%).

Flame:
It is the hot part of fire and has three parts.
- **Innermost region of flame** It is black because of the presence of unburned carbon particles.
- **Middle region** It is yellow luminous due to partial combustion of fuel.
- **Outermost region** It is blue (non-luminous) due to complete combustion of fuel. It is the hottest part of flame and is used by the Goldsmith to heat the gold.

Rocket Fuel:
- The fuel used in rockets is called rocket propellant.
- **Liquid propellants** are alcohol, liquid hydrogen, liquid ammonia (NH_3), kerosene oil etc.
- **Solid propellants** are polybutadiene and acrylic acid used along with oxidizers such as aluminium per chlorate, nitrate or chlorate.

ATMOSPHERIC POLLUTION

Atmospheric pollution
The substance which causes pollution is known as pollutant.
Pollutants are of two types
— **Primary pollutants** persist in the environment in the form, they are produced, e.g. sulphur dioxide (SO_2), nitrogen dioxide (NO_2) etc.
— **Secondary pollutants** are the products of reaction of primary pollutants, e.g. peroxyacetye nitrate (PAN), ozone (O_3), aldehyde etc.

Major Gaseous Air Pollutants
Major gaseous air pollutants are oxides of sulphur, nitrogen, carbon and hydrocarbons.

Sulphur dioxide (SO_2)
It is highly toxic for both animals and plants, bronchitis, asthma, emphysema. It also causes eye and throat irritation and breathlessness.
Sulphur dioxide reduces the rate of formation of chloroplast and thus, causes chlorosis. SO_2 is highly corrosive and damage buildings, marbles (Taj Mahal) and textiles.
SO_2 is oxidized to SO_3 which reacts with water to give H_2SO_4. H_2SO_4 remains suspended in the air as droplets or come down in the form of acid rain.

Oxides of nitrogen
Among the oxides of nitrogen, nitric oxide (NO), a colourless, odourless gas and nitrogen dioxide (NO_2), a brown gas with pungent odour act as tropospheric pollutants.
NO_2 is highly toxic for living tissues causes leaf fall. It is a corrosive oxide and helps in the formation of smog.
In the presence of oxygen, NO_2 reacts with water or moisture and produces nitric acid (HNO_3) which is an important factor for making acid rain.

Carbon monoxide (CO)
From more stable carboxyhaemoglobin complex with haemoglobin due to which the delivery of oxygen to the organs and tissues is blocked.

Hydrocarbons
Out of the hydrocarbons, methane (CH_4) is the most abundant hydrocarbon pollutant. Higher concentrations of hydrocarbons given carcinogenic effect, i.e. are cancer producing. They cause ageing of plants, breakdown of plant tissues and shedding of leaves.

Consequences of Atmospheric Pollution
Green house gases such as carbon dioxide, methane and water vapours trap the heat radiated from Earth. This leads to an increase in Earth's temperature. This heating up of Earth and its objects due to the trapping of infrared radiation by green house gases in the atmosphere, is called **green house effect.**
Green house effect is very essential for the existence of life because in its absence, Earth would be converted into extremely cold planet. When concentration of green house gases increases, green house effect also increases. This is known as **global warming.**
Acid rain
It is caused by the presence of oxides of nitrogen and sulphur in the air. These oxides dissolve in rain water and from nitric acid and sulphuric acid respectively. The rain carrying acids, is called acid rain.

Particulates
Diseases caused by particulate

Diseases	**Cause**
Pneumoconiosis	Due to inhalation of coal dust
Silicosis	Due to inhalation of free silica (SiO_2)
Black lung disease	Found in workers of coal mines
White lung disease	Found in textile workers
Byssinosis	Due to inhalation of cotton fibre dust

Smog
It is two types:
Classical smog
These occur in cool, humid climate. Sulphur dioxide (SO_2) and particulate matter from fuel combustion are the main components of classical smog.

Photochemical smog
These occur in warm, dry and sunny climate. It consists of a mixture of primary pollutants (nitrogen oxides and carbon monoxides) and secondary pollutants (ozone, formaldehyde).
Peroxyacetyl nitrate (PAN) and aldehydes present in smog causes irritation in eyes. PAN has the highest toxicity to plants. It attacks younger leaves and causes bronzing and glazing of their surfaces.

Stratospheric Pollution
In stratosphere, ozone layer absorbs the ultraviolet radiation of the Sun which are harmful to living organisms.
Depletion of ozone layer causes skin cancer and cataract in human and reduction of planktons in ocean and depletion of plants.
Depletion of ozone layer is caused by **chlorofluoro carbons** which are used in refrigeration, fire extinguishers and aerosol sprayers.
In stratosphere, the depletion of ozone layer leading to ozone hole has been mainly observed in the stratosphere of Antarctica.
The formation of this hole occurs due to the accumulation of special clouds in the region called **Polar Stratospheric Clouds** (PSCs) and inflow of chlorofluoro carbons (CFCs).

Water pollution
In some part of India, drinking water is contaminated by the impurities of arsenic, fluoride, uranium, etc.
In water, some dissolved Oxygen (DO) is also present. For a healthy aquatic life, the optimum value of DO is 5-6 ppm. If DO is below 5 ppm, the growth of fishes is inhibited.

Biochemical Oxygen Demand (BOD) is the total amount of oxygen (in mg) required by microbes to decompose the organic matter present in 1L of water sample while **Chemical Oxygen Demand** (COD) refers to the total amount of oxygen (in ppm) consumed by the pollutants in a water sample.

$$BOD = \frac{\text{Amount of oxygen required (in mg)}}{\text{Volume of water sample (in L)}}$$

For clean water, BOD is less than 5 ppm while for highly polluted water; it is 17 ppm or more.

BIOLOGY

CELL

Cell: It is the basic structural unit of life.
Cells were first **discovered** by **Robert Hooke.**
Note: The smallest cell is 0.1 to 0.5 micrometre in bacteria. The largest cell measuring 170 mm ×130 mm, is the egg of an ostrich.
Amoeba acquires its food through **endocytosis.**

- **Endocytosis** is a type of active transport that moves particles, such as large molecules, parts of cells, and even whole cells, into a cell.

Types of cell-

1. **Prokaryotes cells**
   - cells that have no defined nucleus or any other membrane-bound organelle
   - It lacks chloroplast,lysosome,mitochondria
   - **Eg:** Bacteria & Blue-green Algae

2. **Eukaryote**
   - cells which have definite nucleus and is surrounded by nuclear membrane
   - chloroplast,lysosome,mitochondria found in these cells
   - **Eg:** Other than Bacteria & Blue-green Algae

Cellular components-

- **Cell membrane:** It is Outer layer of the cell.Compounds called proteins and phospholipids make up most of the cell membrane.
- **Cell Wall:** It is only found in the plant cells. It 's function is to protect nucleoplasm and cell membrane from external invasion.
- **Nucleoplasm:** It is the protoplasm of the inside nucleus of the cell.
- **Cytoplasm:** It is the fluid that fills a cell. Scientists used to call the fluid protoplasm.
- **Nucleolus:** The **nucleolus** is a round body located inside the nucleus of a eukaryotic cell. The **nucleolus** makes ribosomal subunits from proteins and ribosomal RNA, also known as rRNA.

Cell nucleus: The cell nucleus acts like the brain of the cell. It helps control eating, movement and reproduction. Not all cells have a nucleus.

The nucleus contain, the following components :
(a) Nuclear envelope (nuclear membrane) - It is made up of protein and fat.It is connected through endoplasmic reticulum of the cell.
(b) Chromatin : When the cell is in resting state there is something called chromatin in the nucleus. Chromatin is made up of DNA, RNA and nucleus protein. DNA and RNA are the nucleus acids inside the cell. When the cell is going to divide, the chromatin become very compact. It condenses when the chromatin comes together we can see the chromosomes.
(c) Chromosomes: Chromosomes make organisms what they are. They carry all the information used to help a cell grow, thrive and reproduce.

- Chromosomes are made up of DNA. Chromosomes are not always visible. They usually sit around uncoiled and as loose shards called chromation.
- Chromosomes are usually found in pairs.
- Human Beings probably have 46 chromosomes (23 pairs).
- Peas only have 12, a dog has 78 chromosomes.
- The number of chromosomes is not related to the intelligence or complexity of the creature.
- Segments of DNA in specific patterns are called genes.
- In prokaryotes, DNA floats in the cytoplasm in an area called the nucleoid.

Ribosomes: It synthesis protein, and Endoplasmic reticulum sent these protein in various part of the cell. Whereas Smooth Endoplasmic reticulum helps in the manufacture of fats. It a made up of ribonucleic acid.

Functions of these proteins and fats:

- Protein and fat (lipid) help in building the cell membranes. This process is known as **membranes biogenesis.**
- Smooth Endoplasmic reticulum plays a crucial role in detoxifying many poisons and drugs.

Golgi apparatus : It is another packaging organelle like the endoplasmic reticulum **functions:**

- It is the organelle that builds lysosomes (cells digestion machines).

Lysosomes(suicidal bag): It is a kind of waste disposal system of the cell.

Mitochondria(power house): The energy required for various chemical activities headed for life is released by mitochondria in the form of ATP (adenosine-tri-phosphate) molecules.

- **ATP is known as the energy currency of the cell.**
- Mitochondria are strange organelles in the sense that they have their own DNA and ribosomes, therefore mitochondria are able to make their own protein.
- Mitochondria is absent in bacteria and the red blood cells of mammals and higher animals.

Plastids: These are present only in plant cells.
Types of plastids:-

- **Chromoplast**(colour plastides) impart colour to flowers and fruits.
- **Leucoplasts**(white or colourless plastids) present in which starch, oils and protein are stored.
- **Plastids** are self-replicating. i.e. they have the power to divide, as they contain DNA, RNA and ribosomes.
- Plastides contains the pigment chlorophyll that is known as **chloroplast**. It is the site for photo synthesis.

  non –living parts with in the cell :-

Vacuoles: It is semi permeable membrane and its main function is to collect food stuff in which minerals salts,sugar,Co_2,organic acids are dissolved.

Granules: It is not bounded by any membranes. It store fats, proteins and carbohydrates.

Cell Division

Organisms grow and reduce through **cell division**.

There are two methods of replication **mitosis** and **meiosis**.

(a) Mitosis: It duplicates its DNA and the two new cells (daughter cells) have the same pieces and generic code. There are five steps in this process. You should remember the term PMATI. It breaks down to : Prophase,Metaphase,Anaphase,Telophase and Interphase.

(b)**Meiosis-** It occurs in the reproductive cells and it produce Gametes. It results in the reduction of chromosome in the daughter cells by half so it is called reduction division.

Centrioles:Centrioles are concerned with cell division. It initiates cell division.

Diffusion-It is a process of movements of substance from a region of high concentration to a region where its concentration is low. Water also obeys the law of diffusion.

Eg: Substances like Co2 and O2 can move across the cell membranes by a process called diffusion.

Osmosis: The movement of water molecules is called osmosis. Osmosis is a special case of diffusion through a selectively permeable membrane.

Types of Osmosis:

1. **Hypotonic:** more water will come into the cell than will leave. The cell is likely to swell up.
2. **Isotonic:** the amount going in is the same as the amount going out of the cell.The cell will stay the same size.
3. **Hypertonic:** more water leaves the cell than enters it. Therefore the cell will shrink.

When a living plant cell loses water through osmosis there is shrinkage or contraction of the contents of the cell away from the cell wall. This phenomenon is known as plasmolysis.

Some important facts regarding cells :

- Nerve cells in animals are the longest cells.
- Smallest human cell is red blood cell.
- Largest human cell is female ovum.
- The single largest cell in the world is of an ostrich.
- The smallest cells are those of the mycoplasma.
- Every minute about 3 million cells in our body die.
- Sieve tube in plants and the mature mammalian red blood cells do not have a nucleus.
- The red blood cell carries respiratory gases.
- Sieve cells in plants transport nutrients in plants.
- The lysosomal enzymes of the sperm cells digest the limiting membranes of the ovum (egg). Thus the sperm is able to enter the ovum.

TISSUE

Tissues are groups of cells that have a similar structure and act together to perform a specific function.There are mainly four types of tissue which are-

I.Epithetical Tissue-

It forms a continuous layer over external and internal free surface of many organs.

(i) On the basis of cell layers

(a) **Simple epithelium:** It is formed from a single layer of cells.It is found on secretory and absorptive surface.

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- On the basis of shape of cells simple epithelium is divided -
  - **Cuboidal : These are are cube-like cells and** its occurrence is in kidney tubules, salivery glands, inner lining of the cheek. Its main function is to give mechanical strength.
  - **Columnar : These are 'column-like cells and** its occurrence is in sweat gland, tear gland, salivary gland its main function is to gives mechanical strength concerned with secretions.
  - **Squamous :** These are are flattened and scale-like cell and it form inner lining of lung alveoi and blood vessels.

(b) **Compound epithelium**: It is consist of more than one layer of cells.It provide protection to issues against mechanical,chemical stress

II.Connective Tissue: These tissues are made up of fibers forming a framewoark and support structure for body tissues and organs.It connect and bind different tissues.

There are a few types of connective tissue.

A. Areolar tissue : It fills spaces inside organs found around muscles, blood vessels and nerves. Its main function is to joins skin to muscles, support internal organs, help in the repair of tissues. Whereas tendon's main function is to connect muscles to bones and ligament is connects bones to each other.

B. Adipose tissue: Its occurrence is below skin, between internal organs and in the yellow bone Marrow. Its main function is to storage of fat and to conserve heat.

C. Skeletal tissue: Bone & cartilage occurrences are in nose, epigotis and in intervertebral disc of mammals. Its main function is to provide support and flexibility to body part. Whereas bone protects internal delicate organs provides attachments for muscles, bone marrow makes blood cells.

D. Fluid tissue: Blood & Lymph blood transport O2 nutrients, hormones to tissues and organs. Whereas leucocytes fight diseases and platelets help in cloting of blood. Lymph transport nutrients into the heart and it also forms the defense system of the body.

E. Ligaments: A ligament is the fibrous connective tissue that connects bones to other bones.It is made up of spindle shaped cells called fibrocytes.

F. Cartilage: It consists of dense matrix of collagen fibres and elastic fibres embedded in rubbery ground substance.Example are peak of nose , exterior part of ear.

III. Muscular Tissue

It is specialized for ability to contract muscle cells. Its contraction and relaxations promote the movements and locomotional activities.

Types of Muscular tissue:

A. Skeletal muscle: It attached primarily to bones. Its main function is to provide the force for locomotion and all other voluntary movements of the body.

B. Cardiac muscle: It occurs only in the heart. The contraction and relaxation of the heart muscles help to pump the blood and distribute it to the various parts of the body.

C. Smooth muscle: It can be found in stomach, intestines, and blood vessels these muscles cause slow and prolonged contractions which are involuntary.

IV.Nervous tissue: This tissue is specialized with a capability to conduct electrical impulses and convey information from one area of the body to another. Most of the nervous tissue (98%) is located in the central nervous system. The brain and spinal cord.

Parts of Nervous Tissue

- **Cyton** – It is main part of nerve cell in which nucleus and cytoplasm are found.
- **Dendron** – These are thin fibre passes through the cyton,it carries impulses towards the cell body
- **Axon** - Axon, also called nerve fibre, portion of a nerve cell (neuron) that carries nerve impulses away from the cell body. A neuron typically has one axon that connects it with other neurons or with muscle or gland cells.

Important facts regarding animal tissue:-

- Muscles contain special protein called contractile protein. Which contract and relax to cause
- Fat storing adipose tissue is found below the skin and between internal organs.
- Two bones are connected to each other by a tissue called ligament. This tissue is very elastic.
- The skin, the living of the mouth, the living blood vessels, kidney tubules are all made up of epithelial tissue.
- Voluntary muscles and cardiac muscles are richly supplied with blood whereas involuntary muscles are poorly supplied with blood.

MUSCULAR AND SKELETAL SYSTEM

Skeletal Systems of Various Animals

Skeletons are a fluid-filled body cavity, exoskeletons, or internal skeletons.

Types of skeleton-

1. **Exoskeleton**- It is found on the exterior layer of the body and it protects and preserves inner organs.
2. **Endoskelton-** The skelton found inside the body is called Endoskelton and it orginates from mesoderm.

Note: Spiders use a combination of an exoskeleton for protection and fluid pressure for movement.

- Sharks, and rays have skeletons composed entirely of cartilage; other vertebrates have an embryonic cartilage skeleton progressively replaced by bone as they mature and develop.
- Some areas of the human body, however, retain cartilage in the adult: in joints and flexible structures such as the ribs, trachea, nose and ears.
- The upper bones of the limbs are single: humerus (arm) and femur (leg).
- Below a joint (elbow or knee), both limbs have a pair of bones (radius and ulna in the arms; tibia and fibula in legs) that connect to another joint (wrist or ankle).
- The carpals makeup the wrist joint; the tarsals are in the ankle joint.

Bone

- Bones have cells embedded in a mineralized (calcium) matrix and collagen fibers.
  The spongy bone of the femur, humerus, and sternum contains red marrow, in which stem cells reproduce and form the cellular components of the blood and immune system. Yellow marrow, at the center of these bones, is used to store fats. The outer layer of the bones is known as the periosteum.
- When fractures occur, the pain is carried to the brain by nerves running through the periosteum.

Skeletal Muscle Systems

When one muscle flexes (or contracts) the other relaxes, a process known as **antagonism**.

Muscles have both electrical and chemical activity.

Contraction of Non-muscular Cells

- Some fish have modified muscles that discharge electricity. These fish have electric organs consisting of modified muscles known as electroplates. The South American electric eel has more than 6000 plates arranged into 70 columns. Maximum discharge is 100 watts.

THE NERVOUS SYSTEM

- The Central Nervous System (CNS) includes the brain and spinal cord.
- The Peripheral Nervous System (PNS) connects the CNS to other parts of the body, and is composed of nerves(bundles of neurons)

The Neuron

Nervous tissue is composed of two main cell types: neurons and glial cells. Neurons transmit nerve messages. Glial cells are in direct contact with neurons and often surround them.

The neuron is the functional unit of the nervous system. Humans have about 100 billion neurons in their brain alone! While variable in size and shape,

Functions of the three parts of a neuron:

- **Axon:** It conducts messages away from the cell body.
- **Dendrite**: It receives information from axon of another cell and conducts the messages towards the cell body.
- **Cell body**: It contains nucleus, mitochondria, and other organelles. It is mainly concerned with the maintenance and growth.

SYNAPSES

The junction between a nerve cell and another cell is called a synapse.

The space between two cells is known as the synaptic cleft.

- The function between two neurons is called a 'ganglion'.

HUMAN EYE

The human eye is like a camera. Its lens system forms an image on a light-sensitive screen called the retina.

The eyeball is approximately spherical in shape with a diameter of about 2.3 cm.

The eye lens forms an inverted real image of the object on the retina.

RETINA -> The retina is a delicate membrane having enormous number of light-sensitive cells.

CORNEA -> Light enters the eye through a thin membrane called the cornea.It is the eye's outermost layer. It is the clear, dome-shaped surface that covers the front of the eye. It plays an important role in focusing your vision.

PUPIL -> The pupil is a hole located in the centre of the iris of the eye that allows light to strike the retina. It appears black because light rays entering the pupil are either absorbed by the tissues inside the eye directly, or absorbed after diffuse reflections within the eye. The pupil regulates and controls the amount of light entering the eye.

IRIS -> It is a dark muscular diaphragm that controls the size of the pupil and thus the amount of light reaching the retina.

CILIARY MUSCLE -> The ciliary muscle is a ring of smooth muscle in the eye's middle layer that controls accommodation for viewing objects at varying distances and regulates the flow of aqueous humour into Schlemm's canal. It changes the shape of the lens within the eye, not the size of the pupil.

The light-sensitive cells get activated upon illumination and generate electrical signals. These signals are sent to the brain via the optic nerves. The brain interprets these signals, and finally, processes the information so that we perceive objects as they are.

Note: When the light is very bright, the iris contracts the pupil to allow less light to enter the eye. However, in dim light the iris expands the pupil to allow more light to enter the eye. Thus, the pupil opens completely through the relaxation of the iris.

A human being has a horizontal field of view of about 150° with one eye and of about 180° with two eyes.

HUMAN BRAIN

The brain is the most complex part of the human body. This three-pound organ is the seat of intelligence, interpreter of the senses, initiator of body movement, and controller of behavior.

The brain can be divided into three basic units:

- The forebrain,
- The midbrain, and
- The hindbrain

The **forebrain** is the largest and main thinking part of the brain. It has regions which receive sensory impulses from various receptors. Separate areas of the fore-brain are specialised for hearing, smell, sight and so on.

The **Midbrain** connects the forebrain to the hindbrain.

The **hindbrain** controls the body's vital functions such as respiration and heart rate.

»CEREBRUM [Largest part of the human brain]

- It sits at the topmost part of the brain.
- It is the source of intellectual activities.
- It holds your memories, allows you to plan, enables you to imagine and think.
- It allows you to recognize friends, read books, and play games.
- It controls the voluntary motor actions.
- It is the seat of learning and memory.
- It is the site of sensory perceptions; like tactile and auditory perceptions.
- It is divided into two hemispheres; called cerebral hemispheres.

»HYPOTHALAMUS

- It lies at the base of the cerebrum.
- It controls sleep and wake cycle (circadian rhythm) of the body.
- It also controls the urges for eating and drinking.
- It gets the adrenaline flowing during a test or job interview.

»CEREBELLUM

- It lies below the cerebrum and at the back of the whole structure.
- It coordinates the motor functions.
- It is responsible for precision of voluntary actions and maintaining the posture and balance of the body.
- Example: When you are riding your bicycle; the perfect coordination between your pedaling and steering control is achieved by the cerebellum.

»MEDULLA

- It forms the brain stem; along with the pons.
- It lies at the base of the brain and continues into the spinal cord.
- It controls various involuntary functions
- Example: heartbeat, respiration, size of the pupil, blood pressure, salivation and vomiting etc.

»THALAMUS

- A major clearinghouse for information going to and from the spinal cord and the cerebrum.
- Cerebrospinal fluid (CSF) is a watery fluid that circulates through the brain's ventricles (cavities or hollow spaces) and around the surface of the brain and spinal cord.

»SPINAL CORD:

- The rear part of medulla oblongata forms the spinal cord.It control the activities of reflex actions.It carry forward the incoming pulse signal of the brain.

THE ENDOCRINE SYSTEM

This system is basically composed of various specific glands that produce and secretes harmones,chemical substance produced in human body.

Hormones

The endocrine system is a collection of glands that secrete chemical messages we call hormones. These signals are passed through the blood to arrive at a target organ, which has cells possessing the appropriate receptor.

Exocrine glands (not part of the endocrine system) secrete products that are passed outside the body. Sweat glands, salivary glands, and digestive glands are examples of exocrine glands.

Hormones are grouped into three classes based on their structure:

1. steroids 2. Peptides 3. Amines

Types of gland-

(a)**Exocrine gland-**

- In this gland secrets fluid are transported through duct to various organs outside the body

(b)**Endocrine gland-**

- This is a ductless gland and secretes harmones are brought through th blood plasma..

ENDOCRINE GLAND OF THE BODY

Adrenal gland

The adrenal glands (also known as suprarenal glands) are endocrine glands that produce a variety of hormones including adrenaline.

They are found above the kidneys.

Hypothalamus

The hypothalamus is a portion of the brain that contains a number of small nuclei with a variety of functions.

Function: link the nervous system to the endocrine system via the pituitary gland.

Pituitary gland
It is an endocrine gland about the size of a pea and weighing 0.5 grams in humans.
Hormones secreted from the pituitary gland help control:

- growth,
- blood pressure,
- certain functions of the sex organs,
- metabolism,
- pregnancy,
- childbirth,
- nursing,
- water/salt concentration,
- temperature regulation
- pain relief.

Thyroid
The thyroid gland, or simply the thyroid is one of the **largest endocrine glands** in the body.
It is found in the interior neck, below the Adam's apple.

- It secretes two hormones: triodothyro (T3) and tetraiodothysonine (T4), are called tyrosine. Both these hormones contain iodine.
- Hypothyroidism (hypo, 'under')–diminished thyroid activity. Hypothyroi-dism in childhood gives rise to a conditions called cretinism.

It controls rate of use of energy sources, protein synthesis, controls the body's sensitivity to other hormones.
Goiter– is called enlargement of the thyroid gland. It manifests itself as a swelling in the neck.
A goiter may be associated with increased, normal or descreased activity of the thyroid gland.
Government of India launched the Universal salt iodisation programme in 1986.

Adernal gland

- It produce aderaline and steroid and it is located above the kidney.It is also called as fight harmone.It has two components- Cortex and Medulla

Pancreas
The pancreas is a glandular organ in the digestive system and endocrine system of vertebrates.
In humans, it is located in the abdominal cavity behind the stomach.

It produce several important hormones

- Including insulin,
- Glucagon,
- Somatostatin, and
- Pancreatic polypeptide which circulate in the blood.

The pancreas is also a **digestive organ**, secreting pancreatic juice containing digestive enzymes that assist digestion and absorption of nutrients in the small intestine. These enzymes help to further **break down** the **carbohydrates, proteins, and lipids in the chyme**.

Reduction on the quantity of effective insulin gives rise to diabetes mellitus (diabetes, siphon, mellitus of honey) commonly called simply diabetes.

Saliva: Tylene, Maltase
Gastric Juice: Pepsin, Renin
Pancreatic Juice: Trypsin, Amylase, Lipase
Intestinal Juice: Erepsin, Maltase, Lactase, Sucrase, Lipase

LYMPHATIC SYSTEM AND IMMUNITY

The Lymphatic System

- The spleen serves as a reservoir for blood, and filters or purifies the blood and lymph fluid that flows through it.
- If the spleen is damaged or removed, the individual is more susceptible to infections.

Immunity

- **Antibodies:** Antibodies are a type of protein molecule known as **immunoglobulins**.

BLOOD

- Blood is a fluid connective tissue.
- The quantity of blood in the human's body is 7% of the total weight.
- pH value of blood is 7.4.
- There is an average of 5-6 litres of blood in human body.
- Female contains half litre of blood less in comparison to male.
- It also fights infection and regulates temperature.

Blood cells are produced in BONE MARROW
The main functions of blood are to transport oxygen, carbon dioxide, water, nutrients, hormones and waste around the body. Blood also fights infection and regulates temperature.
Blood has four components:

1. Plasma
2. Red blood cells
3. White blood cells
4. Platelets

PLASMA -> Liquid portion of Blood

- It constitutes for about 54% of our blood. 92% of it is water.
- maintaining a satisfactory blood pressure

- volume to supplying critical proteins for blood clotting and immunity.
- medium for exchange of vital minerals such as sodium and potassium
- helps to maintain a proper pH (acid-base) balance in the body, which is critical to cell function.

RED BLOOD CELLS -> Carry oxygen

- Red blood cells are disc-shaped cells containing haemoglobin,
- haemoglobin (haem=iron-containing)
- Haemoglobin enables the cells to pick up and deliver oxygen to all parts of the body, then pick up carbon dioxide and remove it from tissues.
- Its life span is from 20 days to 120 days and are then broken down into pigments called bilirubin and biliverdin in the liver.
- Its destruction takes place in liver & spleen. Therefore, liver is called grave of RBC.
- they are made in the bone marrow,
- they have no nucleus,
- N.B. oxyhaemoglobin =oxygen rich haemoglobin,
- deoxyhaemoglobin=low oxygen haemoglobin

WHITE BLOOD CELLS -> Defend Body (Fighter)

- White blood cells, also called leukocytes
- White cells are the body's primary defense against infection.
- They can move out of the blood stream and reach tissues to fight infection.
- They are essential for good health.
- Its life span is from 1 to 2 days.
- White blood cells have nuclei and are also made in the bone marrow.

PLATELETS-> Responsible for clotting
Platelets are the cells that circulate within our blood and bind together when they recognize damaged blood vessels.

Study of blood = HEMATOLOGY

THE CIRCULATORY SYSTEM

HUMAN HEART

The human heart is an organ that pumps blood throughout the body via the **circulatory system**, supplying oxygen and nutrients to the tissues and removing carbon dioxide and other wastes.

The human heart has four chambers:

- The right atrium and right ventricle together make up the "**right heart**,"
- the left atrium and left ventricle make up the "**left heart**."
- A wall of muscle called the **septum** separates the two sides of the heart.
- **Valves prevent backflow,** keeping the blood flowing in one direction through the heart.

A double-walled sac called the ***pericardium*** encases the heart, which serves to protect the heart and anchor it inside the chest.
Between the outer layer, the **parietal pericardium**, and the inner layer, the **serous pericardium**, runs pericardial fluid, which lubricates the heart during contractions and movements of the lungs and diaphragm.

The heart's outer wall consists of three layers:-

- The outermost wall layer, or **epicardium,** is the inner wall of the pericardium.
- The middle layer, or **myocardium,** contains the muscle that contracts.
- The inner layer, or **endocardium,** is the lining that contacts the blood.

The **sinoatrial node** produces the electrical pulses that drive heart contractions.

HUMAN HEART FUNCTION

The heart circulates blood through two pathways:

1. The pulmonary circuit
2. The systemic circuit

In the pulmonary circuit, deoxygenated blood leaves the right ventricle of the heart via the pulmonary artery and travels to the lungs, then returns as oxygenated blood to the left atrium of the heart via the **pulmonary vein.**

In the systemic circuit, oxygenated blood leaves the body via the left ventricle to the aorta, and from there enters the arteries and capillaries where it supplies the body's tissues with oxygen. Deoxygenated blood returns via veins to the **vena cava,** re-entering the heart's right atrium.

The ***cardiovascular system*** circulates blood from the heart to the lungs and around the body via blood vessels.

Blockage of any artery can cause a heart attack, or damage to the muscle of the heart. A heart attack is distinct from cardiac arrest, which is a sudden loss of heart function that usually occurs as a result of electrical disturbances of the heart rhythm.

The heart contains electrical "pacemaker" cells, which cause it to contract — producing a heartbeat.
The aorta is the main artery leaving the heart.
The pulmonary artery is the only artery that carries oxygen-poor blood.
The pulmonary artery carries deoxygenated blood to the lungs.
The veins have valves that prevent backflow of blood
Blood pressure.

Important Points:

➧ **Aorta**
The largest artery in the body. It carries oxygen-rich blood away from the heart to vessels that reach the rest of the body.

➧ **Atria**
The chambers of the heart, to which the blood returns from the circulation.

➧ **Capillaries**
The smallest of the body's blood vessels. Oxygen and glucose pass through capillary walls and enter the cells. Waste products such as carbon dioxide pass back from the cells into the blood through capillaries.

➧ **Cardiac Valves (Heart Valves)**
Any of the four heart valves that regulate the flow of blood through the chambers of the heart.

➧ **Oxygenated Blood** -> Oxygen-rich blood.

➧ **Deoxygenated Blood** -> Oxygen-poor blood.

➧ **Heart Ventricles**
The lower right and left chambers of the heart.

➧ **Interventricular Septum**
Interventricular septum is the stout wall separating the lower chambers (the ventricles) of the heart from one another.

➧ **Lungs**
One of a pair of organs in the chest that supplies the body with oxygen, and removes carbon dioxide from the body.

➧ **Myocardium**
The muscular substance of the heart; the middle of the three layers forming the outer wall of the human heart.

➧ **Pulmonary Artery**
The pulmonary artery and its branches deliver blood rich in carbon dioxide (and lacking in oxygen) to the capillaries that surround the air sacs.

➧ **Pulmonary Circulation**
The circulation of the blood through the lungs.

➧ **Pulmonary Veins**
The veins that return the oxygenated blood from the lungs to the left atrium of the heart.

➧ **Superior Vena Cava**
The large vein that carries blood from the head, neck, arms, and chest to the heart.

➧ **Vena Cava**
A large vein which returns blood from the head, neck and extremities to the heart.

➧ Endothelium is the innermost layer of blood vessels that consists of just a single layer of cells.

➧ Veins are blood vessels that carry blood to the heart in an even flow. They have thin walls large lumens and valves.

➧ A pulse is the alternate contraction and relaxation of an artery as blood passes through it.

➧ Blood pressure is the force blood exerts on the walls of blood vessels.

➧ A sphygmomanometer is used for measuring blood pressure(normally 120/80 mmHg)

➧ Atherosclerosis is the hardening of artery walls due to a build-up of fatty deposits.

➧ Smoking causes heart rate and blood pressure to increase. Diet high in saturated fats increase blood pressure and atherosclerosis. Exercise helps lower blood pressure.

Blood Groupings

- Father of Blood Grouping : Karl Landsteiner
- He discovered A, B and O blood groups
- Decastello and Sturle discovered AB blood groups

RH factor

- It is a blood antigen found in RBC
- A person can be Rh+ or Rh- depending upon the presence of Rh factor in RBC
- Rh+ can receive blood from both Rh+ and Rh- but Rh- can receive blood only from Rh- only

Blood transfusion techniques was developed by Dr. James Blundell.

THE REPRODUCTIVE SYSTEM

➢ Asexual reproduction allows an organism to rapidly produce many offspring without the time and resources committed to courtship, finding a mate, and mating.

➢ The hydra produces buds; starfish can regenerate an entire body from a fragment of the original body.

Sexual Reproduction

- In sexual reproduction new individuals are produced by the fusion of haploid gametes to form a diploid zygote.
- Sperm are male gametes, ova (ovum singular) are female gametes.
- Meiosis produces cells that are genetically distinct from each other.
- Fertilization is the fusion of two such distinctive cells.

Human Reproduction and Development

- Gonads are sex organs that produce gametes. Male gonads are the testes, which produce sperm and male sex hormones. Female gonads are the ovaries, which produce eggs (ova) and female sex hormones.

The Male Reproductive System

- Sperm production begins at puberty and continues throughout life, with several hundred million sperm being produced each day. Once sperm form they move into the epididymis, where they mature and are stored.

External Genitals

- The female external genitals are collectively known as the vulva.

Sexually Transmitted Diseases

STDs can affect the sex partners, fetus, and newborn infants. STDs are grouped into three categories.

Category One

STDs that produce inflammation of the urethra, epididymis, cervix, or oviducts. Gonorrhea and chlamydia are the most common STDs in this category. Both diseases can be treated and cured with antibiotics, once diagnosed.

Category Two

STDs that produce sores on the external genitals. Genital herpes is the most common disease in this class. Symptoms of herpes can be treated by antiviral drugs, but the infection cannot be cured. Syphilis is a bacterially caused infection, and can, if left untreated, cause serious symptoms and death. However, the disease is curable with antibiotics.

Category Three

This class of STDs includes viral diseases that affect organ systems other than those of the reproductive system. AIDS and hepatitis B are in this category. Both can be spread by sexual contact or blood. Infectious individuals may appear symptom-free for years after infection.

The separation of intercourse from pregnancy uses methods blocking one of the three stages of reproduction

- release and transport of gametes
- fertilization
- implantation

PLANT REPRODUCTION

Flowers

Reproductive parts of the flower are the stamen (male, collectively termed the androecium) and carpel (often the carpel is referred to as the pistil, the female parts collectively termed the gynoecium).

Pollen

Pollen grains contain the male gametophyte (microgametophyte) phase of the plant. They are produced by meiosis of microspore mother cells that are located along the inner edge of the anther sacs (microsporangia).

Pollination

The transfer of pollen from the anther to the female stigma is termed pollination. This is accomplished by a variety of methods:

Entomophyly is the transfer of pollen by an insect.

Anemophyly is the transfer of pollen by wind.

Other pollinators include birds, bats, water, and Humans.

Double Fertilization

The process of pollination being accomplished, the pollen tube grows through the stigma and style toward the ovules in the ovary.

Fruit

The ovary wall, after fertilization has occurred, develops into a fruit. Fruits may be fleshy, hard, multiple or single.

Note:- Seeds germinate, and the embryo grows into the next generation sporophyte.

PLANT HORMONES-

HORMONES	FUNCTION
Auxin	• Controls growth of plant • Prevent separation of leaves
Gibberellins	• It turns dwarf plant into long plants • Break dormancy of plants • Help seeds to sprout
Cytokinins	• Help in the cell division and development. • Break dormancy of plants • Helps in making of RNA and Protein.
Abscisic Acid	• It is growth against harmone. • Helps seed and bud to be in the dormant conditions.
Ethylene	• Ripening of fruits • Increased number of female flowers.

Xylem – It is a conducting tissue which has function of conduction of water and minerals

Pholem – It is a conducting tissue whose main function is to conduction of foods prepared by leaves to other part of plant.

Transpiration- It is loss of water of plant from its aerial part.

THE DIGESTIVE SYSTEM

Stages in the Digestive Process
1. MOVEMENT : propels food through the digestive system
2. SECRETION : release of digestive juices in response to a specific stimulus
3. DIGESTION : breakdown of food into molecular components small enough to cross the plasma membrane
4. ABSORPTION: passage of the molecules into the body's interior and their passage throughout the body
5. ELIMINATION: removal of undigested food and wastes

The human digestive system, is a coiled, muscular tube (6-9 meters long when fully extended) stretching from the mouth to the anus.

The Mouth and Pharynx
Chemical breakdown of starch by production of salivary amylase from the salivary glands into glucose. This mixture of food and saliva is then pushed into the pharynx and esophagus.

The STOMACH

Gastric juice in stomach contains:
- **hydrochloric acid(HCl),**
- **pepsinogen, and**
- **mucus**

Functions of Hydrochloric Acid (HCl) :
- It kills microorganisms.
- It lowers the stomach pH to between 1.5 and 2.5.
- It lowers pH of the stomach so pepsin is activated.

Pepsinogen is an enzyme that starts protein digestion and controls the hydrolysis of proteins into peptides.
Chyme, the mix of acid and food in the stomach, leaves the stomach and enters the small intestine.
Alcohol and aspirin are absorbed through the stomach lining into the blood.
Epithelial cells secrete mucus that forms a protective barrier between the cells and the stomach acids.

ULCERS
Peptic ulcers result when these protective mechanisms fail.
Bleeding ulcers result when tissue damage is so severe that bleeding occurs into the stomach.
Perforated ulcers are life-threatening situations where a hole has formed in the stomach wall.
At least 90% of all peptic ulcers are caused by Helicobacter pylori.
Other factors, including stress and aspirin, can also produce ulcers.

THE SMALL INTESTINE

- The small intestine is the major site for digestion and absorption of nutrients.
- it is about 22 feet (6.7 meters) long.

Parts of small intestine:
1. **Duodenum**
2. **Jejunum**
3. **Ileum**

- Sugars and amino acids go into the bloodstream via capillaries in each villus.
- Glycerol and fatty acids go into the lymphatic system.
- Starch and glycogen are broken down into maltose by small intestine enzymes.
- **Maltose, sucrose, and lactose** are the main carbohydrates present in the small intestine; they are absorbed by the microvilli.
- Enzymes in the cells convert these disaccharides into monosaccharides that then leave the cell and enter the capillary.
- **Gluten enteropathy** is the inability to absorb gluten, a protein found in wheat.
- Fat digestion is usually completed by the time the food reaches the ileum (lower third) of the small intestine. Bile salts are in turn absorbed in the ileum and are recycled by the liver and gall bladder.

LIVER
The liver produces and sends bile to the small intestine via the hepatic duct.
Bile contains cholesterol, phospholipids, bilirubin, and a mix of salts.

In addition to digestive functions, the liver plays several other roles:
(1) detoxification of blood;
(2) synthesis of blood proteins;
(3) destruction of old erythrocytes and conversion of haemoglobin into a component of bile;
(4) production of bile;
(5) storage of glucose as glycogen, and its release when blood sugar levels drop; and
(6) production of urea from amino groups and ammonia.

GALL BLADDER

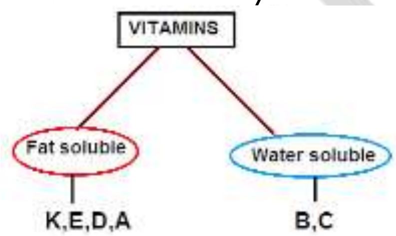
It **stores excess bile** for release at a later time.
We can live without our gall bladders, in fact many people have had theirs removed. The drawback, however, is a need to be aware of the amount of fats in the food they eat since the stored bile of the gall bladder is no longer available.
Glycogen is a polysaccharide made of chains of glucose molecules.
In plants starch stored in the form of glucose, while animals use glycogen for the same purpose.

Low glucose levels in the blood cause the release of hormones, such as glucagon, that travel to the liver and stimulate the breakdown of glycogen into glucose, which is then released into the blood(raising blood glucose levels).
When no glucose or glycogen is available, amino acids are converted into glucose in the liver.The process of deamination removes the amino groups from amino acids. Urea is formed and passed through the blood to the kidney for export from the body. Conversely, the hormone insulin promotes the take-up of glucose into liver cells and its formation into glycogen.
Liver Diseases Jaundice occurs when the characteristic yellow tint to the skin is caused by excess hemoglobin breakdown products in the blood, a sign that the liver is not properly functioning.
Hepatitis A, B, and C are all viral diseases that can cause liver damage.
Cirrhosis: Cirrhosis of the liver commonly occurs in alcoholics, who place the liver in a stress situation due to the amount of alcohol to be broken down. Cirrhosis can cause the liver to become unable to perform its biochemical functions. **Chemicals responsible for blood clotting are synthesized in the liver, as is albumin, the major protein in blood.**

(D) The Large Intestine
The large intestine is made up by the colon, cecum, appendix, and rectum.

VITAMINS

Vitamins: Vitamins are organic molecules required for metabolic reactions. They usually cannot be made by the body and are needed in trace amounts. Vitamins may act as enzyme cofactors or coenzymes.



VITAMIN K (Phylloquinone)
SOURCE
Green leafy vegetables, soya beans. The human body can also produce Vitamin K through germs in the colon(part of small intestine).
FUNCTION
- Helps blood clotting, prevent over bleeding
- Maintains health of the liver

SYMPTOMS OF DEFICIENCY
Uncontrol bleeding from wounds due to clotting difficulty
SYMPTOMS OF EXCESS
Can lead to liver damage

VITAMIN E (Tocopherol)=Beauty Vitamin
It is also known as Antisterility Vitamin.
SOURCE
Green leafy vegetables, whole-wheat cereals, nuts, sprouts, egg yolk

FUNCTION
- Maintains normal conditions of cells, and healthy skin and tissues
- Protects red blood cells
- Antioxidation
- Enhance immunity

SYMPTOMS OF DEFICIENCY
New born infants: haemolytic anaemia
Adults: weakness

SYMPTOMS OF EXCESS
- Low thyroxine level
- Fertility Desease
- Headache, dizziness, fatigue
- Stomach discomfort, poor appetite

VITAMIN D (Calciferol)=(Sunhine Vitamin)
SOURCE
Egg yolk, liver, cod liver oil, fish. Our skin also produces Vitamin D when exposed to sunlight.

FUNCTION
- Helps body absorb and utilize calcium and phosphorus, so as to maintain bones, teeth and brain healthy
- Maintains normal calcium level in blood

SYMPTOMS OF DEFICIENCY
Children: rickets
Adults: Osteomalacia, Osteoporosis

SYMPTOMS OF EXCESS
- Calcified cartilage
- High calcium level in the blood causes abnormal heart beat and damage to organs such as kidneys
- Vomiting, diarrhea
- Sore eyes
- Itchy skin

VITAMIN A (Retinol)
SOURCE
Dairy products, cod liver oil,liver, dark green and yellow vegetables and fruits
FUNCTION
- Maintains eye health
- Promotes growth and development, maintains healthy bones and teeth
- Enhances the protection and regeneration of cells and mucous membrane
- Maintains healthy respiratory and intestinal tracts
- Maintain healthy hair, nails and skin

SYMPTOMS OF DEFICIENCY
- Night blindness, dry eyes
- Dry skin
- Stomach discomfort
- Poor growth
- Weak bones and teeth

SYMPTOMS OF EXCESS
- Dry, scaly, peeling, and itchy skin, rash
- Hair loss
- Poor appetite, fatigue
- Vomiting, stomach discomfort
- Liver injury
- Headache, bone pain
- Nervousness, irritability

VITAMIN B

VITAMIN B1 (Thymine)
SOURCE
sprouts, yeast
Desease
Beri-beri

VITAMIN B2 (Ryboflabin)
SOURCE
sprout, present in cow's milk(yellowish)
Desease
Cheilosis, ulceration

VITAMIN B6 (Pyridoxine)
FUNCTION
It is responsible for rememeber dreams.
SYMPTOMS OF DEFICIENCY
Anaemia
Nervousness, insomnia, depression
Muscle cramps

VITAMIN C (Ascorbic acid)
SOURCE
Citrus fruits (orange, grapefruit, lemon), strawberry, black current, kiwi fruit, tomato, green leafy vegetables, green pepper

FUNCTION
- Helps synthesize collagen; promotes the growth and repair of cells, gum, teeth, blood vessels and bones
- Helps healing after operation and injury
- Helps calcium and iron absorption
- Enhances immunity

SYMPTOMS OF DEFICIENCY
- Scurvy
- Gum
- inflammation and bleeding, fall of teeth
- Susceptibility to skin bleeding, burst of capillary vessels
- Weakness, fatigue
- Bone pain, swollen and aching joints

SYMPTOMS OF EXCESS
- Abdominal pain
- Diarrhea
- Kidney stone

In smokers and drinkers vitamin C is absent.

TYPES OF VITAMINS:

Vitamin	Chemical Name	Food Sources	Deficiency Diseases
A	Retinol	Milk, eggs, fish, butter, cheese and liver.	Night blindness, Skin dryness.
B1	Thiamine	Legumes, whole grain, nuts.	Beri-beri.

B2	Riboflavin	Egg, milk, cheese, nuts, bread products.	Inflammation of tongue, sores in the corners of the mouth.
B3	Niacin or Nicotinic acid	Meat, fish, pea nuts, whole grain.	Skin disease, diarrhoea, depression, dementia.
B5	Pantothenic acid	Eggs, liver, dairy products.	Fatigue, muscle cramp. Pellagra
B6	Pyridoxine	Organ meats, cereals, corn.	Anaemia, kidney stones, nausea, depression.
B12	Cyanocobalamin	Meat, fish.	pale skin, constipation, fatigue.
C	Ascorbic acid	Oranges, tomatoes, sweet and white potatoes.	Scurvy, anaemia, ability to fight infections decreases.
D	Calciferol	Direct sunlight, fish oils, eggs.	Rickets, osteomalacia.
E	Tocopherol	Vegetable oils, olives, tomatoes, almonds, meat, eggs.	Neurological problems, problems of reproductive system.
K	Phylloquinone or Naphthoquinone	Soyabeans, green leafy vegetables, dairy products, meat.	Failure to clot blood.

Minerals: Iron(for hemoglobin), iodine (for thyroxin), calcium (for bones), and sodium (nerve message transmission) are examples of minerals.

Digestion in Animals Facts from NCERT

- Starfish feeds on animals covered by half shells of calcium carbonate.
- The saliva breakdown the starch into sugar.
- Liver situated in the upper part of the abdomen on the right side. It is the largest gland in the body.
- In the process of digestion carbohydrates get broken down into simple sugars such as glucose. Fats into fatty acid and glycerol. Proteins into amino acid.
- The grass is rich in cellulose a type of carbohydrates human cannot digest cellulose.
- Amoeba is a microscopic single celled organism found in pond water. When it sense food, it pushes out one or more finger like projection (pseudopodia) around the food particles and engulf it and then the food becomes trapped in a food vacuole.

THE EXCRETORY SYSTEM

Excretory Systems in Various Animals

Components of this system in vertebrates include the kidneys, liver, lungs, and skin.

Water and Salt Balance

The excretory system is responsible for regulating water balance in various body fluids.

Osmoregulation refers to the state aquatic animals are in: they are surrounded by freshwater
and must constantly deal with the influx of water.

Excretory System Functions

1. Collect water and filter body fluids.
2. Remove and concentrate waste products from body fluids and return other substances to body fluids as necessary for homeostasis.
3. Eliminate excretory products from the body.

The Human Excretory System

The urinary system is made-up of the kidneys, ureters, bladder, and urethra. The nephron, an evolutionary modification of the nephridium, is the kidney's functional unit.

The nephron has three functions:

1. Glomerular filtration of water and solutes from the blood.
2. Tubular reabsorption of water and conserved molecules back into the blood.
3. Tubular secretion of ions and other waste products from surrounding capillaries into the distal tubule.

Kidney Stones

In some cases, excess wastes crystallize as kidney stones. They grow and can become a painful irritant that may require surgery or ultrasound treatments.

Kidney Functions

1. Maintain volume of extracellular fluid
2. Maintain ionic balance in extracellular fluid
3. Maintain pH and osmotic concentration of the extracellular fluid.
4. Excrete toxic metabolic by-products such as urea, ammonia, and uric acid.

Kidneys, The Fascinating Filters

Nephron is the filteration unit of kidney.

- Excessive eating (polyphagia), excessive drinking (polydipsia) and too much of urine (polyusia) are three cardinal symptoms of diabetes. The 'hypothesis' produces a chemical substance called 'antidivretic hormone (ADH).
- The Adrenal gland maintains the regulating salt in the body and is located in an organ lying just over the kidney. As soon as the salt (sodium) concentration become just a little less than normal, it release into the blood stream a substance called 'aldosterone'.
- Renal transplantation or dialysis (artificial kidney) are the supportive measure when the damage to kidney reaches a certain point.

Hormone Control of Water and Salt

Water reabsorption is controlled by the antidiuretic hormone (ADH) in negative feedback.

ADH is released from the pituitary gland in the brain. Dropping levels of fluid in the blood signal the hypothalamus to cause the pituitary to release ADH into the blood. ADH acts to increase water absorption in the kidneys.

Aldosterone, a hormone secreted by the kidneys, regulates the transfer of sodium from the nephron to the blood. When sodium levels in the blood fall, aldosterone is released into the blood, causing more sodium to pass from the nephron to the blood. This causes water to flow into the blood by osmosis. Renin is released into the blood to control aldosterone.

PHOTOSYNTHESIS

- The raw materials of photosynthesis, water and carbon dioxide, enter the
- cells of the leaf, and the products of photosynthesis, sugar and oxygen leave the leaf.
- Water enters the root and is transported up to the leaves through specialized plant cells known as xylem.
- Carbon dioxide cannot pass through the protective waxy layer covering the leaf (cuticle), but it can enter the leaf through an opening flanked by two guard cells.
- Likewise, oxygen produced during photosynthesis can only pass out of the leaf through the opened stomata.

Chlorophyll and Accessory Pigments

- Chlorophyll, the green pigment common to all photosynthetic cells absorbs all wavelengths of visible light except green, which it reflects to bedetected by our eyes.
- Black pigments absorb all of the wavelengths that strike them.

DIVERSITY IN LIVING ORGANISMS

Differentiation in Plants

Thallophyta

- The plants in this group are commonly called algae. These plants are predominantly aquatic.
  E.g. : Spirogyra, cladophora and chara.

Bryophyte

- These are called the amphibians of the plant kingdom. There is no specialized tissue for the conduction of water and other substances from one past of the plant body to another.
  E.g. : moss (fumaria) and marchantia

Pteridophyta

- In this group plant body is differentiated into roots, stem and leaves and has specialized tissue for the conduction of water and other substances from one plant of the plant body to another. Eg- marsilea, ferns, and horse tails.

Gymnosperms

- The plant of this group bear naked seeds and one usually perennial and evergreen and woody. Eg- pines such as deodar.

Angiosperms

- The seeds develop inside an organ which is modified to become a fruit. These are also called flowering plants.
- Plant embryos in seeds have structures called cotyledons. Cotyledons are called seed leaves because in many instances they emerge and become green the seed germinates.
- Plants with seeds having a single cotyledon are called monocotyledons or monocots. Eg- paphiopedilum.
- Plants with seeds having two cotyledons are called dicots. E.g-Egipomoce.

Pisces

- These are fish. They are cold blooded and their hearts have only two chambers unlike the four that human have.
- Some with skeletons made entirely of cartilage, such as shark.
- Some with skeleton made of both bones and cartilages such as tuna or rohu.

Amphibian

- They have mucus glands in the skin and a three chambered heart. Respiration is through either gills or lungs.
  Eg- frogs, toades, and salamanders.

Reptilia

- These animals are cold blooded have scales and breathe through lungs. While most of them have a three chamber heart while crocodile have four heart chambers. Eg- snakes, turtles, lizards and crocodiles.

Aves
- These are warm blooded animals and have a four chambered heart. They lay eggs. They breathe through lungs. All birds fall in this category.

Mammalia
- They are warm blooded animals with four chambered hearts.
- They have mammary glands for the production of milk to nourish their young. They produce live young ones.
- However a few of them like platypus and the echidna(Spiny Anteater) lay eggs.

MICRO ORGANISMS

Micro organisms are classified into four major groups. These groups are bacteria, fungi, protozoa and algae.
- **Viruses:** They reproduce only inside the cells of the host organisms which may be bacterium, plants or animal.
- Common cold, influnenza and most coughs are caused by viruses.
- Serious diseases like polio and chickenpox are also caused by viruses.
- Micro organisms may be single celled like bacteria, Some algae and protozoa. Multicellular such as algae and fungi.
- Micro organisms like amoeba can live alone, while fungi and bacteria may live in colonies.

Advantages of Micro Organisms
- Making of curd and breed:-milk is turned into curd by bacteria. The bacterium “lactobacillus” promotes the formation of curd.
- Yeast reproduces rapidly and produces CO2 during respiration. Bubbles of the gas fill the dough and increase its volume.
- Yeast is used for commercial production of alcohol and wine. For this purpose yeast is grown as natural sugars present in grains like barley, wheat, rice, crushed fruit juice etc.
- This process of conversion of sugar into alcohol is known as fermentation. Lewis Pasteur discovered fermentation.

Medicinal Use of Micro Organisms
- The medicine which kills or stops the growth of diseases causing microorganism is called antibiotics.
- Streptomycin, tetracycline and erythromycin are some of the commonly known antibiotics. Which are made from fungi and bacteria.
- Alexander Fleming discovered penicillin.
- Antibiotics are not effective against cold and flu as these are caused by virus.

Vaccine
- Edward Jenner discovered the vaccine for small pox.

Harmful Microorganisms
- Disease-causing microorganisms are called pathogens.
- Microbial diseases that can spread from an infected person to a healthy person through air water, food, or physical contact are called communicable diseases. i.e.- cholera, common cold, chicken pox and TB.
- Female anopheles mosquito which carries the parasite of malaria.
- Female aedes mosquito acts as carrier of dengu virus.
- Robert Koch discovered the bacteria (bacillus anthracis) which causes anthrax disease.

Common Methods of Preserving Food in our Homes
- **Chemical method:** salt and edible oils are the common chemical generally used.
- Sodium benzoate and sodium metabisulphite are common preservatives. These are also used in the Jams and squashes to check their spoilage.

Preservation by sugar :
- Sugar reduces the moisture context which inhibits the growth of bacteria which spoil food.
- Use of oil and vinegar prevents spoilage of pickles become bacteria cannot live in such an environment.
- Pasteurized milk : the milk is heated to about 70°C for 15 to 30 seconds and then suddenly chilled and stored.
- This process was discovered by Louis Pasteur. It is called **pasteurisation.**

SOME IMPORTANT TABLES

CLASSIFICATION OF ANIMAL KINGDOM

NAME	FEATURES
A. Phylum Protozoa	• Made of only one cell • All activity take place in unicellular body • Respiration and excretion take place by diffusion. • Ex- Amoeba, Euglena
B. Phylum Porifera	• Muticellular animals • Found in marine water • Skelton is made of calcerous • Ex- Sycon,Sponge
C. Phylum Coelenterate	• Animals are aqauatic • It is present inside body • Ex-Hydra,jelly fish,sea Anemone
D. Phylum Arthopoda	• Body is divided into three parts –Head,Thorax and Abdomen • Jointed leg • Ex- Cockrach,prawn,crab

E. Phylum Annelida	• Unisexual and Bisexual • Annulus body • Ex- Earthworm
F. Phylum Mollusca	• Body divided into head and muscular foot • Respiration through Gills • Blood is colourless • Ex- Octopus,Loligo

Important Facts About Human Body:

Largest and strongest Bone in the body:	Femur (thigh bone)
Smallest Bone in the body:	Stapes in ear
Volume of Blood in the body:	6 litres (in 70 kg body)
Number of Red Blood Cells(R.B.C.):	1. In male: 5 to 6 million/cubic mm
	2. In female: 4 to 5 million/cubic mm
Life span of Red Blood Cells(R.B.C.):	100 to 120 days
Life span of White Blood Cell(W.B.C.):	3-4 days
Time taken by R.B.C. to complete one cycle of circulation:	20 seconds
Other name of Red Blood Cell (R.B.C.):	Erythrocytes
Largest White Blood Cells:	Monocytes
Smallest White Blood Cells:	Lymphocyte
Who discovered Blood Group:	Karl Landsteiner
Blood Platelets count:	150,000 - 400,000 platelets per micro litre
Haemoglobin (Hb):	1. In male: 14-15 gm/100 c.c. of blood
	2. In female: 11-14 gm/100 c.c. of blood
Hb content in body:	500-700 gm
pH of Urine:	6.5-8
pH of Blood:	7.36-7.41
Volume of Semen:	2-5 ml/ejaculation
Normal Sperm Count:	250-400 million/ejaculation
Menstrual cycle:	28 days
Menopause age:	45-50 years
Blood clotting time:	3-5 minutes
Weight of Brain:	1300-1400 gm in human adult
Normal Blood Pressure (B.P.):	120/80 mm Hg
Universal blood donor:	O
Universal blood recipient:	AB
Average body weight:	70 kg
Normal body temperature:	37 degree Celsius
Breathing Rate at rest:	12-16/minute
Number of Spinal Nerves:	31 pairs
Largest Endocrine Gland:	Thyroid gland
Normal Heart Beat at rest:	72 beats per minute
Largest Gland:	Liver
Largest Muscle in the body:	Gluteus Maximus or Buttock Muscle
Smallest Muscle in the body:	Stapedius
Largest Artery:	Aorta
Largest Vein:	Inferior Vena Cava
Largest and longest Nerve:	Sciatic Nerve
Longest Cell:	Neurons (nerve cells)
Minimum distance for proper vision:	25 cm
Pulse rate:	72 per minute
Thinnest Skin:	Eyelids
Weight of Heart:	200-300 gm

Common Drugs and Their Usage:

Drugs/Medicine	Use
Anaesthetics	It is a drug that induces insensitivity to pain.
Antiflatulent	It is a drug that reduces intestinal gas
Antipyretics	It is a drug used to lower body temperature.
Analgesics	It is a drug that is used to prevent or relieve pain. Eg. Aspirin.
Antibiotics	It is a drug that inhibits the growth of or destroys micro-organisms. Eg. Penicillin.
Antihistamines	It is a drug used to relieve symptoms of cold and allergies.
Antispasmodic	It is a drug used to relieve spasm of involuntary muscle usually in stomach.
Antacid	It is a drug used for preventing or correcting acidity, especially in the stomach.
Diuretics	It is a drug that promotes the production of urine.
Laxative	It is a drug used to provide relief in constitpation.

TYPES OF DISEASES

List of Diseases caused by Virus, Bacteria, Protozoa and Worm:

Disease caused by Viruses:

1. Chicken pox - It is caused by Varicella-zoster virus.
2. Small Pox - It is caused by Variola virus.
3. Common Cold -It is caused by Rhinovirus.
4. AIDS (Acquired Immunono Deficiency Syndrome) - It is caused by Human Immunodeficiency Virus (HIV).
5. Measles -It is caused by Measles virus.
6. Mumps -It is caused by Mumps virus.
7. Rabies - It is caused by Rabies virus (Rhabdoviridae family).
8. Dengue fever -It is caused by Dengue virus.
9. Viral encephalitis - It is an inflammation of the brain. It is caused by rabies virus, Herpessimplex, polio virus, measles virus, and JC virus.

Disease caused by Bacteria:

1. Whooping Cough - It is caused by a bacterium called Bordetella pertussis.
2.Diphtheria - It is caused by Corynebacteriumdiphtheriae.
3. Cholera - It is caused by Vibrio cholerae.
4. Leprosy - It is caused by Mycobacterium leprae.
5. Pneumonia-It is caused by Streptococcus pneumoniae.
6. Tetanus -It is caused by Clostridium tetani.
7. Typhoid - It is caused by Salmonella typhi.
8. Tuberculosis -It is caused by Mycobacterium tuberculosis.
9. Plague - It is caused by Yersinia pestis.

DISEASE CAUSED BY PROTOZOANS:

1. Malaria	It is spread by Anopheles mosquitoes. The Plasmodium parasite that causes malaria is neither a virus nor a bacteria	it is a singl e	celled parasite that multiplie s in red blood cells of humans.
2.Amoebi c dysentery	It is caused by Entamoebahistolytic a.		
3.Sleepin g sickness	It is caused by Trypanosomabrucei.		
4. Kala azar	It is caused by Leishmaniadonovani .		

DISEASE CAUSED BY WORMS:

1. Tapewor n	They are intestinal parasites. It cannot live on its own. It survives within the intestine of an animal including human.	
2. Filariasis	It is caused by thread	like filarial nematode worms. Most cases of filaria are caused by the parasite known as Wuchereriaba ncrofti.
3. Pinworm	It is caused by small, thin, white roundworm called Enterobiusvermiculari s.	

VITAMINS AND MINERAL DEFICIENCY DISEASES:

1. Anaemia	It is caused due to deficiency of mineral Iron.
2. Ariboflavinosis	It is caused due to deficiency of Vitamin B2.
3. BeriBeri	It is caused due to deficiency of Vitamin B.
4. Goitre	It is caused due to deficiency of Iodine.
5. Impaired clotting of the blood	It is caused due to deficiency of Vitamin K.
6. Kwashiorkor	It is caused due to deficiency of Protein.
7. Night Blindness	It is caused due to deficiency of Vitamin A.
8. Osteoporosis	It is caused due to deficiency of mineral Calcium.
9. Rickets	It is caused due to deficiency of Vitamin D.
10. Scurvy	It is caused due to deficiency of Vitamin C.

COMMON HUMAN DISEASES AND AFFECTED BODY PART:

Disease	**Affected Body Part**
AIDS	Immune system of the body
Arthritis	Joints
Asthma	Bronchial muscles
Bronchitis	Lungs
Carditis	Heart
Cataract	Eye

Cystitis	Bladder
Colitis	Intestine
Conjunctivitis	Eye
Dermatitis	Skin
Diabetes	Pancreas and blood
Diphtheria	Throat
Eczema	Skin
Goitre	Thyroid gland
Glossitis	Tongue
Glaucoma	Eye
Gastritis	Stomach
Hepatitis	Liver
Jaundice	Liver
Malaria	Spleen
Meningitis	Brain and spinal cord
Myelitis	Spinal cord
Neuritis	Nerves
Otitis	Ear
Osteomyelitis	Bones
Paralysis	Nerves and limb
Pyorrhoea	Teeth
Peritonitis	Abdomen
Pneumonia	Lungs
Rhinitis	Nose
Rheumatism	Joints
Tuberculosis	Lungs
Tonsillitis	Tonsils
Trachoma	Eye

BLOOD GROUP AND ITS CLASSIFICATION :

K.Landsteiner : Classified human beings (1900) in four groups on the basis of the reaction of their blood:A,B,AB and O.

Blood group	***Carries antigen***	***Carries antibody***	***Can donate blood to***	***Can receive blood from***
A	**A**	**B**	**A,AB**	**A,O**
B	**B**	**A**	**B,AB**	**B,O**
AB	**A,B**	**None**	**Only AB**	**Universal Accepter**
O	**None**	**A,B**	**Universal donor**	**Only O**